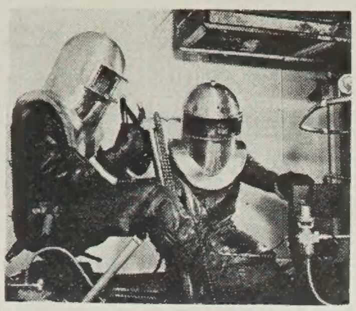

IN THE "cold room" used for aeronautical research at the Douglas Aircraft Company's plant in Southern California, these strangely dressed engineers are conducting research on high-altitude flying equipment. In this room, described in more detail on page 27, the conditions and effects of extremely low temperatures can be studied at leisure under controlled conditions.

SCIENTIFIC AMERICAN

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NINETY-EIGHTH YEAR • ORSON D. MUNN, Editor

JANUARY • 1942

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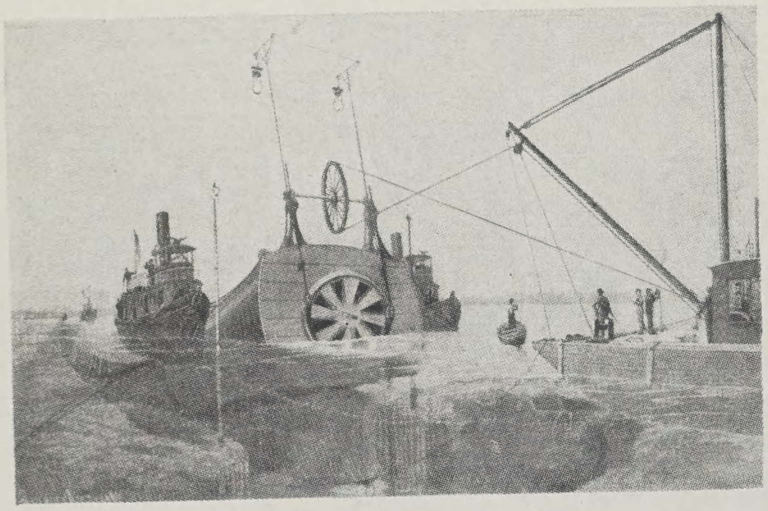
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of January, 1892)

NAVY—"Our navy, as regards material, ships, armor, and ordnance, today is in the first rank among nations. All that is now needed is more ships and proper crews. The ships are being rapidly built. Congress might supplement the work so well in progress by providing for the improvement of the status of recruits, thereby securing intelligent and superior men for the naval service."

TUNNELING—"A method of constructing tunnels under rivers whose beds are of mud, clay, silt, or sand is shown in the illustration. A sectional iron tube is sunk in a cut dredged for it, leveled, topped with clay or concrete in



bags, the cut filled in and working shafts built around the ends. The tunnel tube is then pumped out and bricked up by sections, a roadbed made and junction effected with approaches."

FLEXIBLE GLASS—"Herr Eckstein, an Austrian engineer, claims to have discovered a strong and flexible substance, as transparent as the ordinary brittle glass. . . The material obtained is said to resist the action of salts, alkalies, and acids, and besides being transparent is odorless. It is flexible, and almost unbreakable. . . Any color or shade may be imparted to the new glass."

POWER—"After the completion of the great tunnel works now in progress at Niagara Falls, there will be nothing to hinder the rapid rise and growth of that interesting town into a great and wonderful city. Its dwellings and factories will be supplied with light, heat, and motive power at an extremely low cost, and useful industries of every kind ought there to flourish with unwonted vigor."

CABLE—"The Bahama Islands are soon to be connected with the general telegraphic system of Great Britain and the world. A submarine cable about 200 miles long will be laid from a point about five miles from Nassau, New Providence, to a point about the same distance from Jupiter Inlet, on the southeast coast of Florida."

INSANE GENIUSES?—"Men of genius have not, as a rule, been mad, except with an insanity of a scientific and scholastic kind, such as the world really needs more of. The eccentricities, monomanias, and emotional exaltations of genius have been incidental, and were not the basis of their character and temperament. . . Insanity is a condition in which the power of adjusting one's self and one's conduct to the environment is lost. Surely there is no loss of this kind shown in the work or conduct of men of genius."

"TELETYPESETTING"—"The management of the *London Times* has utilized the telephone in a unique way. Telephone wires have been laid in the underground railway tunnel between the composing room in Printing House Square and the Parliamentary reporters' gallery in the House of Commons. A copy reader placed at the telephone reads the stenographic 'turns' from the note book as fast as it is possible for the compositors to take them on their typesetting machines in the Times building, a mile and a half away."

SAILING—"The demand for sailing vessels has, of late, shown a marked increase both here and abroad; in Great Britain, according to Lloyd's Registry, there being now 141 such craft with a total tonnage of 185,807 under construction against 76 with a tonnage of 80,000 this time last year. Here about the same tendency is manifest. The rate of steamer construction in Great Britain has seen a marked falling off during the year, and though in these waters the rate has largely increased, it may easily be traced to favorable legislation rather than to a further abandonment of the sailing type."

RAIN MAKING—"Nearly all the accounts of the recent rain making experiments in Texas appear to have emanated from, or to have been inspired by, persons who took part in the performances. These reports were, in most instances, grossly exaggerated, and, in some cases, wholly destitute of truth. . . It is understood that an attempt will be made to induce the present Congress to appropriate more money to carry out another series of these foolish fireworks."

CLOGS—"There is a considerable demand for wooden shoes in this country, especially in the Western States and Territories. They are worn by those who have become accustomed to the use of that kind of foot covering in the land of their birth and have not yet adopted the shoes generally worn here, and they are also used by persons who are employed in damp, sloppy places."

SPEED—"On a recent run by a Baldwin compound on the Baltimore & Ohio, hauling a 'Royal Blue' train from Philadelphia to Canton, on December 22, 1891, the time, including one stop at Wilmington and a slow-down at the Susquehanna bridge, requiring three minutes in crossing, was 101 minutes for 91.6 miles."

FORCE—"Man can neither create forces nor endow anything with properties. All that he can do is to convert and combine them into utilities. The man that does this with knowledge is spared the dismal failures of ignorance, but he that tries to use powers without understanding them is inevitably punished for his rash presumption. It is this presumption that causes the mortality and disease that follow in the wake of civilization. Natural law, like the civil, never admits ignorance as an excuse."

'THE MARINES HAVE LANDED...'

A New Way to Have the Situation Well in Hand

A. D. RATHBONE, IV

"COMING on the range!"

In fifteen seconds or so you'll make your first parachute jump! You, Private, First Class, Smith, of the United States Marine Corps, are going to throw your perfectly good body out of a speeding plane at a 1000-foot altitude—and hope to God your parachute opens!

Ever since the training ship took off five minutes ago—an eonic five minutes—you've been in a fog of apprehension. You're as tense as a fiddle string; your hands are clammy; there's a trickle of cold sweat down your spine—but you've laughed and joked with the 11 other neophyte jumpers who are with you in the plane, the lads with whom you've trained four weeks for this moment. Boastfully, you've held out your hand to display steady nerves—and you wonder if they, too, saw it shimmy.

But the jumpmaster's warning command has snapped you out of it. Emphatically dinned and oft-repeated instructions come back to mind in clear, logical order. They disperse that mental haze. You're all hastily untangling legs from sitting positions; you're scrambling to your feet and to your places on the static cable. Static lines are snapped to the cable; left fists grip the clasps 'til knuckles whiten.

"Stand by!"

Here it comes! Another second or two and you'll—

"GO!" shouts the jumpmaster above the roar of the plane's motors, and he slaps the first man on the back and out of the jumping port in the tail of the ship. Swiftly the next man steps up—he's gone!—the next, and the next—you are number seven, lucky seven, you hope—another and another—and you're at the jumping port—with Lilliputian pine trees and roads like strings 1000 feet below!

In that infinitesimal instant in which you're poised on the brink of space, your mind works—works faster and with greater clarity than you had thought possible. In lightning succession you recall that you must let go of your static line; that if the static line doesn't open your troop 'chute, you must grasp the rip-cord ring of your Reserve Training 'chute, cradled like a baby at your chest, with your right hand and pull — pull like hell! — and it's comforting to recall that as yet no initiate into the Leatherneck parachute troops has had occasion to use this safety 'chute—and then—there's nothing solid under foot. You're falling through space!

NATIONAL DEFENSE

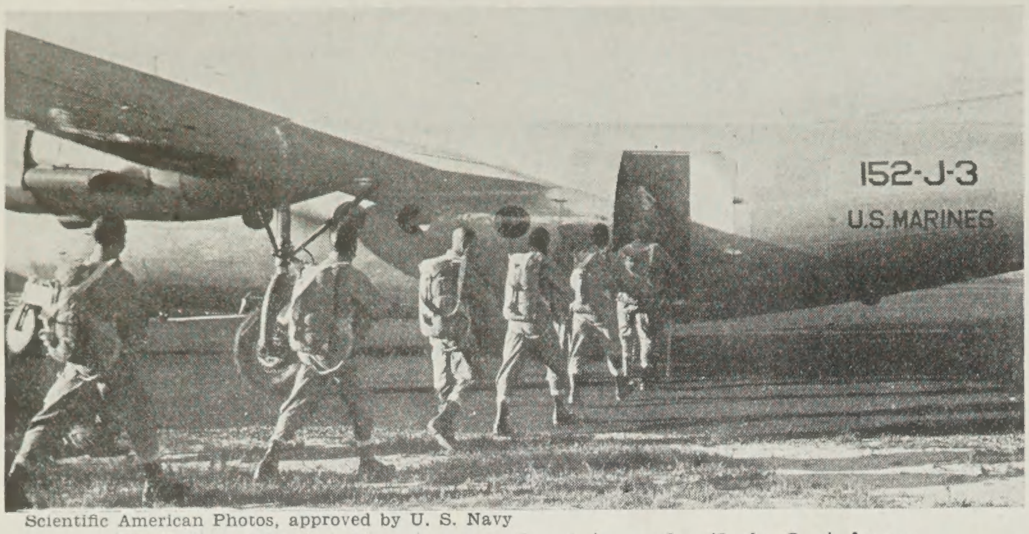
• Material for this article was obtained through the co-operation of the United States Marine Corps. Permission to visit the Marines in training at Lakehurst Naval Air Station was granted by the U. S. Navy. •

Many months ago, when official announcements calling for volunteers for parachute training were tacked on bulletin boards at Marine Corps bases everywhere, hundreds of pairs of eyes eagerly scanned the strict qualifications necessary to enter this adventurous service. The applicant had to be a member of the Regular Marine Corps, or Marine Corps Reserve, with a minimum of six months service behind him and at least a year to go, or else to express a willingness to extend the future service. He had to be between the ages of 21 and 32, unmarried, athletically inclined, well proportioned. He must weigh between 140 and 180 pounds and be not less than 68 nor more than 72 inches tall.

Reading on, you would have learned that volunteers who qualified would receive an extra $50 per month, and you might well have murmured to yourself, "Hmm!" No doubt you would have wondered what the sensation would be, if you flung yourself into space with nothing but a neatly packed silken canopy strapped to your back.

Then, if you had read the order further, you would have found these words: "The nature of the duty involved requires initiative, determination, agility, and strength, and a military and educational background that will qualify men for technical duties of a hazardous nature."

IT'S JUST possible that that "hazardous nature" business would have tipped the scales of your youthful Leatherneck mind in favor of volunteering, for the entire 166-year history of the United States Marine Corps is profusely interwoven with brilliant deed-threads that spell "hazardous nature"—and, after all, one doesn't join the Marines to learn how to knit! Had you suited action to thought, your formal application would have been addressed to the Major General Commandant via the customary official channels. Accompanying it would have been a statement covering your service, educational record, athletic expe-



Scientific American Photos, approved by U. S. Navy

Fledgling Marine Paratroops about to make their first jump

rience. There was also a rigid physical examination in which the medico directed special emphasis toward freedom from organic heart disease, medical history of ankle, knee, or hip injury, if any, and systolic and diastolic blood pressure. In addition, there was a modified flight physical check-up on visual acuity, binocular vision, depth perception, and flight-ear examination as well as a test of equilibrium faculties.

IF, BY chance, you had grown a bit cocky over the physical perfection you had demonstrated for the benefit of the doctors, you would have had that nonsense knocked out of your system in an exceedingly "blitz" manner soon after reporting to Lakehurst Naval Air Station, along with other "perfect" lads from every state in the Union. Your six-week course of training, you would have found, had been arranged in three extremely strenuous periods of two weeks each. The first phase covered conditioning exercises—and were they "conditioning exercises!" They left you, at first, feeling as though you were a worn-out old rooster of 35 years, or so, who just couldn't take it any more. There was also an intensive course in parachute nomenclature and packing instructions; a study of landing methods, including harness training, platform jumping, and practice exits from dummy planes. You learned to roll and tumble around on the ground, like a circus acrobat, with muscles relaxed instead of tightly drawn.

The second two weeks covered more—bigger and better, you might say—conditioning exercises, with more rolls, more tumbles, more back somersaults. There was tower training, which meant utilizing an apparatus comparable to the New York World's Fair parachute jump, a drop of 125 feet in a 'chute guided by control cables. Then came more jumps from a similar apparatus, known as the "fly-away" tower, because the parachute you leaped with was pre-opened before the jump and was held that way by steel ribs, like an umbrella, but there were no guiding cables to direct you or control your landing. It was here, they told you, that a man really proves his readiness for the final phase of jumping from the 'plane. Along with these came parachute packing instructions and study of wind-drags, which included methods of controlling the 'chute through manipulation of the shroud lines.

The final, and most exciting two-week training period included a sort of post-graduate course in those ever-present conditioning exercises. By now they'd built you up from 20 to 45 minutes of exceedingly strenuous calisthenics early every morning except Sundays, with emphasis on leg and abdominal muscle development, capped by a brisk run, which was a half mile long to begin with and had gradually been extended to one and one-half miles. There was further training in parachute care and packing and, at long last, squad jumping from a plane in flight — which had resulted in your stepping off the edge of the plane's jumping port in the general direction of those Lilliputian pine trees and string-like roads, 1000 feet below.

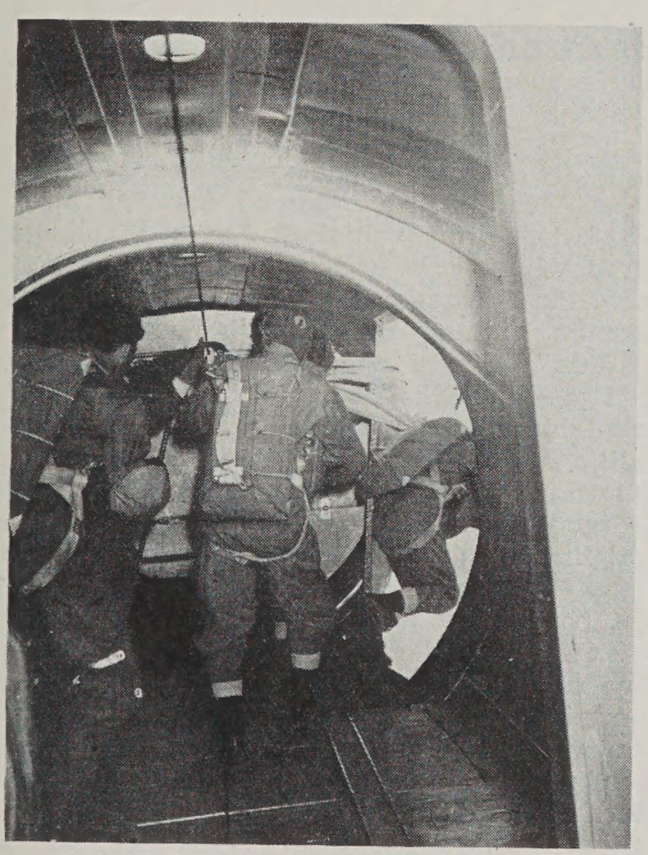
The type of jump you've just begun is known as a "static line fall." Because of the mechanics of the static line, and in contrast to a "free fall" and a "delayed jump," this form of leap may be made from a plane as low as 250 feet in actual war-time operations. This short jump places men and equipment more closely together when they reach the ground, spots them nearer their objective than would a longer drop, and, falling at from 16 to 23 feet per second, offers the enemy far less time to attempt to make targets out of the landing force from the sky. As indicated by the terminology, the latter two types of jumps do not involve use of the static line, that stout, 13-foot strip of two-inch canvas webbing which is such an all-important factor in your present predicament.

YOUR fastidiously packed 'chute reposes in that canvas container strapped to your back. The static line is folded against itself several times and is held in place on the outside of the pack by two loops of elastic webbing. It terminates in a large, metal snap which, at that command, "Coming on the range!" you hooked onto the static cable that is strung lengthwise of the plane. The other terminus of the static line acts as the rip cord, tearing open the fastenings on the pack so the pilot 'chute can per-

Static cable fidgets

form its function of hastening the opening of your 28-foot troop 'chute. In other words, the static line is a mechanical rip cord which obviates the necessity of remembering to pull the rip-cord ring. If, for some reason, the static line doesn't perform, you grab the rip-cord ring of your reserve 'chute and—but why go into that? The static line has worked, the pack is ripped open, the pilot 'chute's released, and in a second or so you're going to receive the most severe yank or jerk your system probably has ever known.

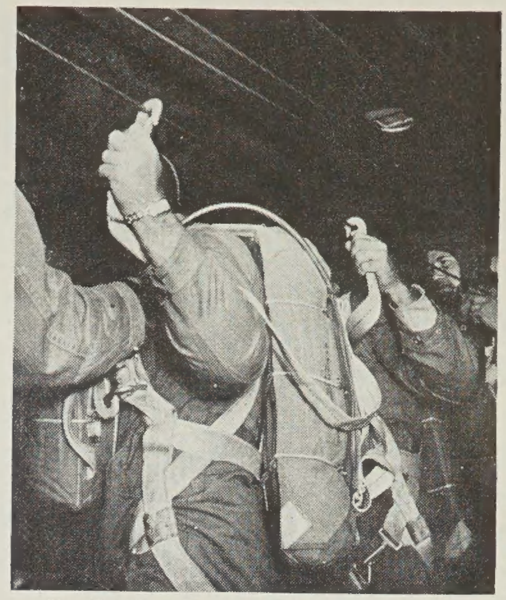
POSSIBLY veteran jumpers can describe sensations and thoughts during the brief seconds that elapse between the leap from the plane and the teeth-loosening wallop that ensues when the 'chute opens and applies sudden brakes to a headlong earthward plunge, but to a neophyte that brief passage of time remains pretty much a blank. Although the parachute harness is designed to distribute the shock of opening to portions of the body best suited to absorb it, the come-uppance you receive when the 28-foot-diametered canopy abruptly goes to work is comparable to an almost instantaneous reduction of traveling speed from about 45 miles an hour to between 15 and 20 miles per hour. In an automobile, such a drastic change of pace might be preliminary to a swan dive through the windshield; in a parachute harness, you have a fleeting sensation that your skeleton is about to slide feet-first out of your body.



Go! (Note static lines at jumping port)

Despite the hours and hours of rigorous preparatory training for this bump in midair—training in which you were hooked into a practice harness, raised by block and tackle to the hangar roof rafters, and allowed to drop 'til the ropes caught you up short—you're surprised and slightly dazed at the short free fall and its sudden cessation. But in an eye's twinkling you're back to normal—as normal as can be expected when, for the first time in your life, you find yourself suspended some 900 feet above earth by 28 silken cords that funnel out from your body to the fluted edge of a gleaming white canopy which hides the sky and your fellow jumpers above you, but which is permitting you to float easily and gracefully downward. Actually, you have the sensation of being poised motionless, with a gentle breeze blowing up your nostrils and whistling past your ears, while the ground comes up to meet you. It's an exhilerating feeling to realize you've made your first parachute jump—that you've actually done it and that everything's under control. You feel like shouting or singing—and maybe you do both.

Now you begin to recall other instructions and more of your intensive training. You mustn't look up. Always look down! Keep your eyes on the ever-approaching ground. There may be rocks, trees, other protuberances that would contribute to an uncomfortable landing, but which may be avoided if you study the terrain below and manipulate your shroud lines properly. Those supporting ropes of braided silk, each with a tensile strength of 450 pounds, constitute the steering mechanism of your strange craft. If you want to drift further to the right, you reach up with both hands, grasp the shroud lines on your right side, and pull. This draws the gores of the 'chute downward, spills air out of the opposite side, and causes the 'chute to slide off to the right. The same procedure applied to the left,



Static lines are hooked to cable

the front, the rear will motivate you in the desired direction, but don't slip too much air out—you might come down faster than good health dictates. All this, you know, you learned while practicing in a captive, stationary 'chute, suspended from the hangar rafters by wires, much like a gigantic umbrella.

THE ground's coming closer! Only a few seconds and you'll put practiced landing technique into operation. You recall the hundreds upon hundreds of training jumps you made from, first, the three-foot platform and, later, the eight-footer. The latter didn't prove much of a shock and you were told that, barring heavy winds or brutal ground conditions, your actual landing would be similar to such a jump. After all, you ruminate, an eight-foot jump, even onto hard ground, is kind of a sissy thing, so long as it's done correctly. You must land on the balls of your feet—never on your toes or flat on your heels. Let the legs spring naturally to take up the shock, and then pivot in the general direction of the wind. This puts you in a squatting-rotating position from which it is easy to follow through with that professional tumbler's back roll you practiced for so long. You simply ease down onto your buttocks, and with a continuous rolling motion in the general direction of the parachute, now falling onto the ground, you do the back somersault, and unless there's a strong wind, the 'chute will shortly collapse like a blown-up paper bag that has been smacked with the palm of the hand.

You're almost down! A couple of fellow Marines are running toward you to be ready with a helping

You're down—safely!

hand—just in case. You remember to reach up and grasp the shrouds on either side of you with both hands, for you're going to "break your fall" as much as possible by "chinning yourself" on the shrouds just before your specially clad feet hit old Mother Earth. Your toes wiggle anticipatorily in the soft leather of the rubber-soled, 10-inch high-tops. You recall having heard stories about broken ankles in the parachute training corps, and how the special shoes were reported to have steel braces for protection, but when your boots were issued to you, they were pliable, soft, and without the slightest trace of steel, and you learned that experiments had proved that the introduction of metal braces produced more injuries than occurred with normal shoes, equipped with rubber soles and the 10-inch uppers.

Ker-thump! You're down! You go into your roll—and, glory be!—it's a perfect landing! Your feet sting slightly and you whacked your head a bit as you rolled, but in the thrill of accomplishment you don't mind, and you scramble to your feet to greet the men who have been running to help you.

So, your first jump is over, and with more prosaic things to do there may come a mental let-down, for, whether you've realized it or not, you have been as carefully prepared psychologically for your initial leap as you were physically. There'll be other jumps, plenty of them, but meanwhile, your first job is to care for your 'chute. With the assistance of a qualified rigger, you collect the shroud lines—a process known as "chaining"—roll up the whole business and get it up to the loft above barracks. There it is suspended by its peak while you and a dozen helpers grasp the fluted edges and "whip silk"—shake and snap the silken expanse to free it of dirt and extraneous matter. If it's wet, it must stay hung up until dry, for a wet 'chute opens slowly. Next, you and your packer will secure the peak to one end of a long table; you'll draw the shroud lines to the other end, check all 28 of them for twists and turn-overs. Again you'll "whip silk" to straighten gores and panels, and fluff it up to remove air pockets. No gentleman's valet, not even the incomparable Jeeves, could fold his master's clothes with greater care than you lavish on the rest of the packing process, but eventually the 'chute is back in its container, the static line is once more folded and secured, and you're ready to jump again.

LATER, after more practice, there'll be squad-jumping in combat maneuvers, with preliminary study of terrain, objectives, imaginary location of enemy forces, airports, water systems, communication lines, and so on, to be demolished or taken over by a daring, fast-moving parachute force. Armed only with an automatic revolver, the squad will float earthward, followed by cargo 'chutes which will transport emergency rations, first-aid supplies, folding bicycles, radio equipment, ammunition, grenades, rifles, machine guns, and mortars. Each squad will practice landing as nearly as possible as a unit—the Marines have jumped 11 men from one plane in six seconds—and the instant each man is on his feet, he'll have his carefully rehearsed part to play in assembling attacking equipment. In an incredibly short time the squad is fully armed and is in action.

Yes, the United States Marine Corps is rapidly acquiring a new method of effectiveness. Shades of old Leathernecks "from the halls of Montezuma to the shores of Tripoli" may well be restless in their hallowed graves at sight of these super-youngsters carrying out the traditional Marine custom of being "first to fight for right and freedom" by dropping from the sky, but it merely will be the 20th Century equivalent of "The Marines have landed and have the situation well in hand"—this time, by parachute.

• • •

Meet the Jeep

The United States Army's Answer to Schicklegruber's Panzer Divisions

JO CHAMBERLIN

IT WAS the second day of the battle of Louisiana. The invaders' tanks roared to the attack near the Sabine River. But the defending forces didn't yield; they didn't even dig in and wait. Their lightning-fast jeeps, towing anti-tank guns, raced into strategic positions, harassed the enemy's advancing tanks, out-maneuvered them, flanked them, cut them off, and cut them down.

The tanks retreated; that particular blitzkrieg was ended. Over and over again the Louisiana maneuvers demonstrated the amazing abilities of Uncle Sam's newest invention, the rugged jeep or bantam car. General George Marshall, Army Chief of Staff, says that it is our main contribution to modern war. A buck private told me: "The blitzbuggy carries more fighting punch per pound than any other army vehicle." A post-maneuver War Department statement of mass-production plans calls the jeep "sensational."

Our army's youngest, smallest, toughest baby has many pet names: jeep, peep, blitzbuggy, jitterbug, beetlebug, iron pony, leaping Lena, panzer-killer. The names are all affectionate, for the jeep has made good. When it was only a year old, it stole the show in the vast Louisiana tank and anti-tank warfare.

I was standing in the hot Mississippi sun while Lieutenant Patrick Summerour, of Camp Shelby, explained the jeep. There were rows of them before us: American Bantam, Ford, and Willys auto makers are turning them out by the thou-

sands. Army goal: 75,000 jeeps.

In front of me was a car 11 feet long, 56 inches wide, 40 inches high—half the height of your family auto and three feet shorter. Weighing only 2200 pounds, the jeep is rugged with power, yet is small enough to be flown in army transport planes. It has no doors, but there are safety straps to keep you from being catapulted out as it tears up and down steep slopes or around hair-raising turns. Normally it carries two passengers in front, one behind. In an emergency it can carry six, the extra men riding on flat front fenders. There are six speeds forward and two reverse. In deep mud, sand, or snow, power can be transmitted to all four wheels.

Lieutenant Summerour lifted up the hood.

"See that engine? Four cylinders. Sixty horsepower. Plenty o' zip, and easy to fix because of standard parts."

He pointed to a rear towing hook.

"You pull an anti-tank gun here. Civilians often ask why we do not fight tanks with tanks. The answer is twofold. In the first place, a jeep costs $900; a tank $35,000. Second, these tank-destroyers, towing anti-tank guns, can swarm round old Shicklegruber's tanks and give 'em hell. It's like David and Goliath—only there are ten Davids for every Goliath."

Photo by U. S. Army Signal Corps.

Steep grades, sand, other tough going are trivia to a "blitzbuggy"

No one man developed the jeep. In the fall of 1940, when the Army was about to buy a large number of motorcycles, the American Bantam Car Company offered the basic idea. Unenthusiastic, the Army nevertheless allotted funds for experimentation and later purchased 1500 cars. General Marshall himself promoted the venture. The first car was delivered in 49 days and proved itself under stiff Quartermaster Corps tests at Camp Holabird, in Maryland. The Corps added ideas. The manufacturers now turn them out wholesale from standardized blueprints.

Designed merely to replace the motorcycle, gruelling tests showed that the jeep could fight as well as run. And it could go places a motorcycle couldn't. Besides, a motorcycle dispatch rider is vulnerable; a single sniper can cut him down, letting vital orders fall into enemy hands. A jeep, carrying armed men and machine guns, is a far tougher proposition. And, vital for combat strategy, the jeep is a clawing, climbing hellion in reaching good places to shoot from.

Lieutenant General Walter Krueger, commanding the Third Army in the Louisiana maneuvers, used the jeep for reconnaissance and command work. It can also serve as a radio patrol car. At Fort Benning, Georgia, it has laid smoke screens to hide the movement of heavy artillery. During battle it can take ammunition, first aid, or food to outposts, can evacuate wounded or get a gun crew out of a doomed position. It can cross bridges too weak for other cars, can reconnoiter rougher terrain. With a mounted 50-caliber machine gun, it can help protect troop columns from airplane strafing.

The War Department has just formed, at Fort Benning, the first air-borne infantry battalion. Planes will transport troops equipped with jeeps, motorcycles, and folding bicycles. The battalion will follow close on the heels of parachute troops in air landing operations.

In Mississippi, I learned first-hand what it was like to ride in a jeep across pine-studded acres at 50 miles an hour. I learned, also, that much of its effectiveness depends on the driver's boldness and ability. It was like driving a Model T Ford across a ploughed field. I was riding a steel bronco, held loosely in my seat by a safety belt. Lieutenant Summerour rocked easily beside me as though cantering his horse in Central Park, apparently enjoying the ride.

He slowed down our jeep and straddled a half-buried log, front wheels tilted to the sky. I visualized a shattered crankcase but was shown guard bars underneath for just such protection. Grabbing special handles on the body, we lifted the car and shoved it easily off the log.

Army strategists especially admire the jeep's "low silhouette." Only three and a third feet high, the jackrabbit-like jeep is hard to spot in brush country, still harder to line a gun on.

"Let's take a tactical problem," suggested Summerour as we were driving along. "S'pose we are out in front, scouting the enemy, and he fires on us from a hidden position—we dive for cover, —fast!"

He slammed on the brakes, turned sharply left, and stopped the car behind a protective knoll.

"Then we locate the enemy fire," he went on, "and blast him. We're so darned low it's hard for him to see us."

At 25 miles per hour he headed for a huge live oak with gnarled branches close to the ground. I was expecting him to swerve suddenly to demonstrate the jeep's maneuverability. Soon I saw that it was not his intention to swerve at all.

"Duck!" he yelled.

I ducked.

We roared under the lowest branch—the top of our car missing it by inches. Only then did I realize that I had stowed my 190 pounds in the narrow space between seat and cowl—and had

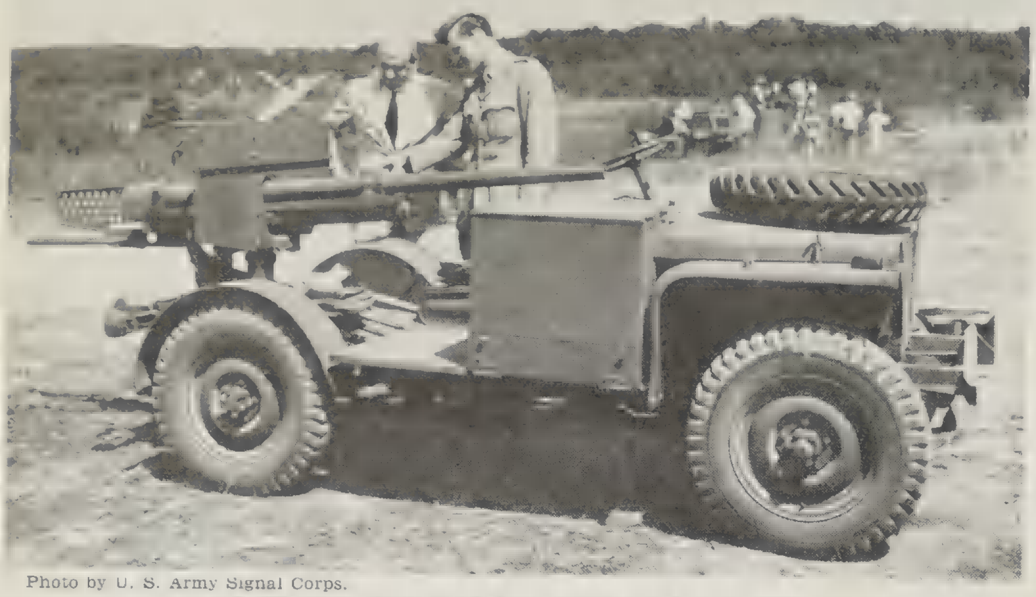


Photo by U. S. Army Signal Corps.

A 37 mm. anti-tank gun mounted on a jeep

lots of leg and arm room to spare!

"Plenty o' clearance," my driver remarked.

We crossed a small stream, water flowing over the floor. But we had no trouble, for electric units are placed so high that the 40-inch jeep can keep going through water 18 inches deep. We clawed our way up the 30-degree bank—twice as steep as you'll ever meet in a passenger car on the highway.

Rivers are an army's worst obstacle in enemy country, and raft or bridge builders offer splendid targets. It was enlightening, therefore, to see jeeps ferried across streams atop three rowboats, on rafts of empty oil cans, and on stray logs wired together. Latest plan is to lay a heavy tarpaulin on the ground, drive the bantam on it, fold up the sides, then drag it into the water where it will float with some support. Tacticians call this simplicity, plus.

Back in camp, in the warehouse section, Lieutenant Summerour gave me one more thrill. He drove the car up a narrow ramp to a railway loading platform, drove along the platform, steered through the open door of a boxcar, passed through the car to a ramp on the other side, and down to the street.

"Think we've got something here?" he asked, getting out of the bantam. I certainly did.

A heavier version of the jeep is the "swamp buggy," with bus-size tires for deep snow and mire. Most important, it's mounted anti-tank gun can be fired forward. It is not towed behind. This means quicker striking power.

In the Louisiana maneuvers, involving 400,000 troops, Army eyes were on its three new anti-tank battalions. All include jeeps and well-armed jeep-riding soldiers. Company A, of the 94th Anti-tank Battalion, for example, has 51 jeeps, some drawing anti-tank guns, others carrying ammunition.

The jeep has helped mightily to lay the legend of tank invincibility. Brigadier General Ira T. Wyche, commanding the 1st Provisional Anti-tank Group, says cheerfully: "We might retire if attacked by heavy opposing infantry, but never from a tank outfit." Already the jeep has made major changes in army concepts of cross-country mobility. It also fits into the traditional American notion of individual action in war.

When war ends, jeeps can do useful work. An artillery officer told me they would aid certain kinds of farming which need practical "Model T Ford" type transportation. Or, with a few trimmings for looks and the spur of low gasoline consumption, the jeep might make good in cities. Lessons learned by jeep manufacturers surely will be put to practical use in improving your car and mine.

Editor's Note: In the nomenclature of our Armored Divisions—which has reached almost the stage of a special argot—the term "jeep" is used to designate the one and one-half ton command car, while the miniature combat car, so often pictured in mid-air, is known as the "peep"—sometimes, "the son of a jeep." This is according to advices from the Bureau of Public Relations of the War Department, which explains that in other branches of the Army, however, "jeep" and the various names mentioned in the above article refer to a bantam car.

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DECOY BLACKOUTS

Dummy Airfields, Deserted Roads, and Empty Areas

Dummy airfields with dimly shining lights, wide open spaces illuminated to simulate crowded areas, and long lines of glowing street lamps on deserted roads are now being studied as a means of literally camouflaging whole cities in event enemy bombers reach America's shores.

"Tragic ineffectiveness of London and Berlin to protect themselves from night raiders with total darkness is forcing the United States government and commercial lighting experts to seek startling new blackout techniques, many of them secret," according to Samuel G. Hibben, Westinghouse blackout lighting engineer.

Since there appears to be no way of preventing bombers from dumping their lethal loads over the centers of blacked-out cities, engineers are now studying means of inducing them by camouflage to aim their bombs where direct hits will cause little or no damage, Mr. Hibben declares. He points out that in the camouflage version of the blackout, decoy airfields, highways and industrial centers could be changed for each raid. They would be located well out of the way of residential areas.

From the air, a string of partially concealed lights along a deserted stretch of road would appear to be a main artery leading into the city. Actually it might point in an entirely different direction. Anti-aircraft and searchlight batteries located several miles from a metropolitan center would be just as effective but would tend to draw pilots away from vulnerable areas. A broad rectangle of flood lights anywhere would serve as airfield decoys. Americans who drive cars with sleek, black tops probably will be obliged to swab their autos with some dull, removable finish in event of air raids. Even moonlight reflection on the tops of closely parked cars offers an ideal target from the air.

Insanity

Paranoia; Dementia Praecox, or Schizophrenia; Paresis; Senile Dementia; Toxic Insanity

L. J. PANKOW, M.D., B.M., B.S.

PARANOIA was formerly believed to be a form of insanity in which the patient was insane on one subject only, and mentally normal on all other subjects. This is now known to be false, for the paranoid suffers from a general mental slowing and degeneration. The paranoid suffers from very definite and well systematized delusions. This definitely affects his judgment, especially in matters pertaining to his delusions. Paranoia usually follows a definite course of three stages. The condition may become arrested in any of the stages, and remain there for years. The stages may be reversed and the third stage may occur very early. The first stage usually begins in childhood, although it may not be recognized at that time. These patients are said to have been queer, taciturn, morose, avoiding other children and associating with older persons. The patient begins to feel that people are acting differently toward him. Older patients at this stage frequently complain that they fear they are losing their minds or their health. This gradually progresses into the second stage, ushered in by delusions of persecution and corresponding hallucinations, especially of hearing.

Up to this time the subject has suspected that people were cold and aloof to him, but now he knows it, and hears them saying unpleasant things about him. The voices are very apt to become vulgar and terrible, accusing him of crimes and sins. Other hallucinations substantiate this belief. People are poisoning his food, are trying to gas him or to injure him with electricity. He builds elaborate defenses against these dangers, sealing up all doors and windows, or setting his bed in saucers of water as insulation. After a time he begins to recognize the individual who persecutes him and instead of they who are persecuting him, it becomes he.

When the patient changes his ideas from *them* to *him*, he becomes dangerous. At first he flees from his persecutors, then he defends himself, and, finally, he strikes in retaliation. Having retained some of his mental faculties he is able to reason to some extent, and so is very dangerous. This stage may last for years before giving way to the third stage, the stage of ideas of self-importance. He begins to see that being such an object of persecution, he must be someone of great import. At this stage, the dual personalities or alterations of person appear. With this stage comes a more pronounced mental deterioration and enfeeblement even to an ultimate complete loss of mentality.

DEMENTIA praecox is a form of insanity in which there are delusions and hallucinations and various mental disorders. The mental deterioriation shows to a marked degree early in the disease, and the delusions are much more fleeting and changeable. Usually, dementia praecox is seen in younger persons, but this is not invariably so. Recently, the name schizophrenia has been suggested. This means splitting of the psyche, and refers to the fact that in these cases there are frequently two or more trains of thought traveling together simultaneously.

In general, dementia praecox also has its beginning in childhood with some oddity being apparent. These patients usually have been dull, but may have been unusually bright. They are frequently shut-in types, having no one with whom they can talk over their problems. Some of the exciting factors of insanity come along and set them off into a recognizable psychosis. It is impossible to guess the subject's reactions and answers. A question may bring a totally unrelated answer, a command may bring an opposite action, or no action at all. All this is due to his twin or double train of thought. This also accounts for the incoherence of speech found so regularly in these cases, and to the emotional deterioration. There are three types of dementia praecox, but these types may overlap or combine to give apparently more types.

Pure dementia praecox, or hebephrenia, is one type. A very mild form is sometimes called the simplex type or abortive form. This is a stationary form in which the disease has not progressed far enough to be called real insanity, when it becomes halted. The patient is able to lead a more or less normal existence except that his personality is greatly changed. It is from this class that hoboes, prostitutes, cranks, eccentrics, and criminals develop.

CATATONIA, or catatonic dementia praecox, a second type, has the usual onset and general symptom syndrome plus catatonia. Catatonia is an irregular alternation of excitement and stupor. In stupor we find negativism and muscular tension. These may be mild or severe, varying from being scarcely noticeable to so severe that the patient lies perfectly quiet in bed, refusing to speak, ignoring the calls of nature, holding the saliva till it putrifies and responding, if at all, to a command by an opposite action. A muscular rigidity resists all efforts to change the position of the body parts, and provides grotesque facial expressions held for long periods at a time. The condition may express itself in a waxy condition of the muscles and, while the limbs are easily moved by the examiner, they remain in the final position for long periods, dropping only from exhaustion. Catatonic excitement is just the opposite of the stupor, being shown in constant talking, tossing in bed, walking, and becoming maniacal. Talk has no goal, and is often completely incoherent. The patients are very impulsive, follow their impul-

Originally published in *The Journal-Lancet*, Minneapolis, Minnesota. The author, with a medical degree from the University of Minnesota, is a Sioux Falls, South Dakota, general practitioner who served on his county insanity board for 15 years, and the article is based on his studies and experiences during that time. In a previous article in the December number, he discussed the general nature of insanity.

sions, and are unable to explain any reason for their violent acts.

The third form of dementia praecox is the paranoid form. This is a usual dementia praecox with considerable dementia and paranoid symptoms added. The paranoid symptoms differ from true paranoia in that the delusions are fleeting and changeable, and not well organized. They are usually persecutory in nature, but the type of persecution will vary from day to day. Such patients do not try to explain to their associates the reasonableness of their delusions as do the true paranoids.

A VERY frequent and most unhappy form of insanity is the manic - depressive, circular or cyclic insanity. The chief symptom of this disease is the recurrence of periodic phases of exaltation or mania alternated with phases of depression or melancholia. Usually accompanying these abnormal states are either corresponding or reversed expressions of motor activity. This means that a patient may be quite maniacal in his thoughts but quite normal or even subnormal in his physical activity, or the converse. Usually, however, the physical state corresponds to the mental state, the patient being agitated when in a mania and quiet when depressed. Some patients do not exhibit an alternation, but have cycles of mania or excitement only, and others have only cycles of melancholia, either being interspersed with apparently quite normal intervals. It is the recurrence of symptoms in a definite cycle that gives the disease the name of cyclic insanity.

The usual findings during a manic phase are a flight of ideas, emotional excitement and increased motor activity. Hallucinations and delusions may develop, and if they do, they are usually of a grandiose nature. The depression or melancholic phase is the exact opposite of the maniacal. It is characterized by difficulty of thinking, emotional depression and decreased motor activity. When normal or nearly so the patients have quite an insight into their condition, and will discuss it intelligently with their associates. This type of psychosis is explained on the basis that when excited the patient is trying to keep up with his problems and is, in his mind, doing so. When in a depression, the problems of adjustment have simply overwhelmed him with their multiplicity and magnitude.

The psychoses so far described are those in which there is no demonstrable physical change in the brain structure itself. They are pure psychoses, or alterations of thinking due to the inability of the patient to deal with the problems of environment and society. There are also insanities in which the mind would, perhaps, never have failed had it not been injured or diseased. Aside from actual injuries to the brain with actual loss of brain tissue, it may be due to scar formation, pressure atrophy of brain tissue due to tumors, abscess, meningitis, depressed skull fractures; or the injury may be the result of infection or toxin from within the body, or drugs. The manifestations are apt to vary, depending on the extent of the injury, the degree of toxicosis, the parts of the brain involved, and the thing causing the effect.

PARESIS is the first of this type of insanity to be discussed. It was a well defined disease entity long before it was learned that it is invariably caused by syphilis. Synonymous with the term paresis was the name "general paralysis of the insane," because it is more than just a psychosis. Before death, the patient invariably develops quite typical motor as well as mental symptoms. While every case of paresis is syphilitic in origin, not every case of syphilis develops paresis, nor does every case of neuro-syphilis have paresis. Locomotor ataxia, for example, is syphilis of the nerves of the spine, but not always is it found in a combination with insanity, and when it is so found, it is referred to as tabo-paresis. Early in the course of paresis, the only symptoms noticeable are a gradual deterioration of the intelligence, defects of judgment, memory loss and evidences of moral delinquencies. These things constitute the first stage of the disease.

The second stage usually presents physical changes added to the mental changes noted before and in addition more pronounced mental defects. The physical things easily noted are muscular tremors especially of the muscles of speech. These cause a peculiar quality of tremulousness in speaking certain words and phrases. A progressive general muscular weakness follows. Frequently, the patient is subject to seizures similar to apoplexy or epilepsy, which usually last longer than an epileptic fit, and disappear more quickly than an apoplectic insult. They leave very little or no motor paralysis, but it is very likely that there will be a very marked mental deterioration noticed after the spell, and the patient does not recover from this mental paralysis. The new level of mentality becomes his normal plane, and a new seizure will sink the mentality to a new low level. Memory fails more and more as the disease progresses, and all the mental defects of the first stage become more pronounced. Delirium develops, emotions are lost, speech becomes difficult, but not yet entirely lost.

AT THIS point in the disease, paresis usually follows one of four types, and little more than mention of them should serve to differentiate them. They are: the demented, in which loss of mentality is the chief symptom; the excited, in which there is terrific mental activity with expansive and grandiose ideas; the agitated, in which there is a great deal of motor excitement and the patient must be constantly on the go; and the depressed, in which one finds symptoms similar to those found in the depressed phase of a cyclic insanity, but with no alternation of the phases. It is usual that paretics are discovered in one of these four types of the second stage of their disease.

The third stage is the final curtain for the paretic. It is the final, eventual and complete breakdown of the mentality. The patient ceases to have any human reactions whatever, and exists like a vegetable, totally unable to care for himself in any manner, losing control of his sphincters, soiling himself and finally being unable even to feed himself. These things constitute the major and most easily recognized symptoms of paresis. The most constant and dependable are the speech difficulties and the positive Wassermann reaction in an insane person.

The senile dementias have one thing in common that allows grouping them together. That thing is that changes incident to age so lower the threshold of mental bal-

ance that complexes and conditions which have been previously handled or compensated satisfactorily, are now allowed to come to the surface, and so manifest themselves as psychoses. Involutional melancholias, various delusions, anxieties, and true senile dementias, with incident memory and judgment failures, egotism and paranoid ideas are examples of this condition. Arterio-sclerotic dementias are probably expressions similar to these, with the added insult of brain starvation and actual loss due to atrophy. To an appreciable extent, the psychosis will be manifested by and dependent upon the area of the brain altered by the sclerosis. One almost constant finding in all cases is an increasing forgetfulness for recent affairs and events, faces, names and places. This obtains in the arteriosclerotic types, chiefly, and accounts for the frequency with which this type gets lost when a very short distance from home, and indeed, even within the home itself.

The last group comprises the infection, exhaustion and toxic types of insanity. These, in addition to the deliria, may simulate more or less any of the types discussed before; but, in general, when the disease has been cured, the infection removed, the toxin eliminated, or the exhaustion corrected, the psychosis improves. It is just that the patient has a low threshold, and the waste products that have accumulated have weakened the defenses of the mentality, allowing some of the problems that have been compensated to decompensate. The patient gets out of adjustment with his environment until the body balance has been restored. Any of the symptoms expected in almost any of the other insanities mentioned may be found as well as some manifestations which are new and strange.

In conclusion, only the high-spots of the symptoms and signs of the common types of insanity have been discussed. There is, however, one thought which should be emphasized: The inability of persons to adjust themselves satisfactorily to their environments and problems, introduces a big field in preventive psychotherapy. Just as a weak rope will break when overloaded, so a mind breaks when it tries to carry a load too heavy for itself. Poorly adjusted individuals and those whose minds can be likened to weak ropes, should be helped to make a proper or a satisfactory adjustment, not by demanding more from them than they can carry mentally, but by finding for them a field of endeavor where the problems will not be more severe and heavy than they can carry.

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IMPAIRED SIGHT

Induced by Insulin Offset by Oxygen

Administration of doses of 100 percent oxygen will offset the impaired sight induced by insulin, according to Dr. Ernst Gellhorn, professor of physiology at the University of Illinois. This sight impairment takes place, he points out, as a result of the close relation between oxygen and blood sugar content. Administration of insulin in "shock" therapy, for example, decreases excess sugar in the blood, deprives the brain of some of the sugar which it burns, and thus produces visual disturbances including loss of the ability to see "after images."

"It was found," Dr. Gellhorn says, "that the effect of low blood sugar induced by insulin was alleviated by inhalation of 100 percent oxygen."

ASYLUMS

Some Mental Hospitals Are a "Disgrace"

"Some mental hospitals are a disgrace!" This serious charge is made by the National Committee for Mental Hygiene in its annual report, just published.

A recent nation-wide survey conducted by the Committee reveals, the report states, a "dismal failure of state authorities in many parts of the country to provide adequately for the mentally ill.

"The depression has put in its deadly work, and standards of care in many institutions have fallen far below the requirements of modern psychiatric practice—in some places to such a point as to suggest a reversion to the conditions of the old asylum era."

Institutions in all parts of the nation are excessively crowded, the survey revealed. This is considered due partly to the fact that the average length of life has been extended 13 years in the last 40 years. Mental disease affects more individuals proportionately among old people than in the younger age groups. One person out of 20, it is estimated, will become a patient in a mental hospital some time during his lifetime.

In probably 12 or 13 states, the superintendent of a state hospital is a political appointee. He may be chosen, not because of his knowledge of mental illness, but because his cousin carried three districts in the south of the state. And he is subject to instant dismissal whenever the political regime changes. This condition makes the whole staff of the hospital, even when they are thoroughly competent professionally, feel insecure. The best men are apt to leave such a hospital and go into other work or to another state.

ATHLETE'S FOOT

Infection Reduced by New Flooring

The danger of acquiring athlete's foot and warts on the soles of the feet from swimming pool runways, locker and shower rooms may be reduced by use of a copper cement flooring material called Hubbellite, Dr. W. L. Mallmann, of Michigan State College, reports in the *Journal of the American Medical Association,* according to *Science Service.*

When the fungus that causes athlete's foot was spread on blocks of glass plate, ordinary cement, and Hubbellite, Dr. Mallmann reports, the fungi multiplied on the glass plate and ordinary cement to double and triple the original number after four and eight hours. On the Hubbellite the fungi were reduced from 72,000 to 74 after eight hours.

Hubbellite was developed by D. S. Hubbell at the Mellon Institute for Industrial Research at Pittsburgh. It is said to owe its germ-killing property to the minute amounts of a copper compound which are released from the flooring when it is wet. It was effective not only when wet with water but when milk was smeared over it, Dr. Mallmann found, suggesting its usefulness on the floors of dairies and kitchens to help keep down germs.

Malodorous Mercaptans

Removal of Sulfur Compounds From Gasoline Gives Greater Susceptibility to Ethyl Fluid

H. W. FIELD

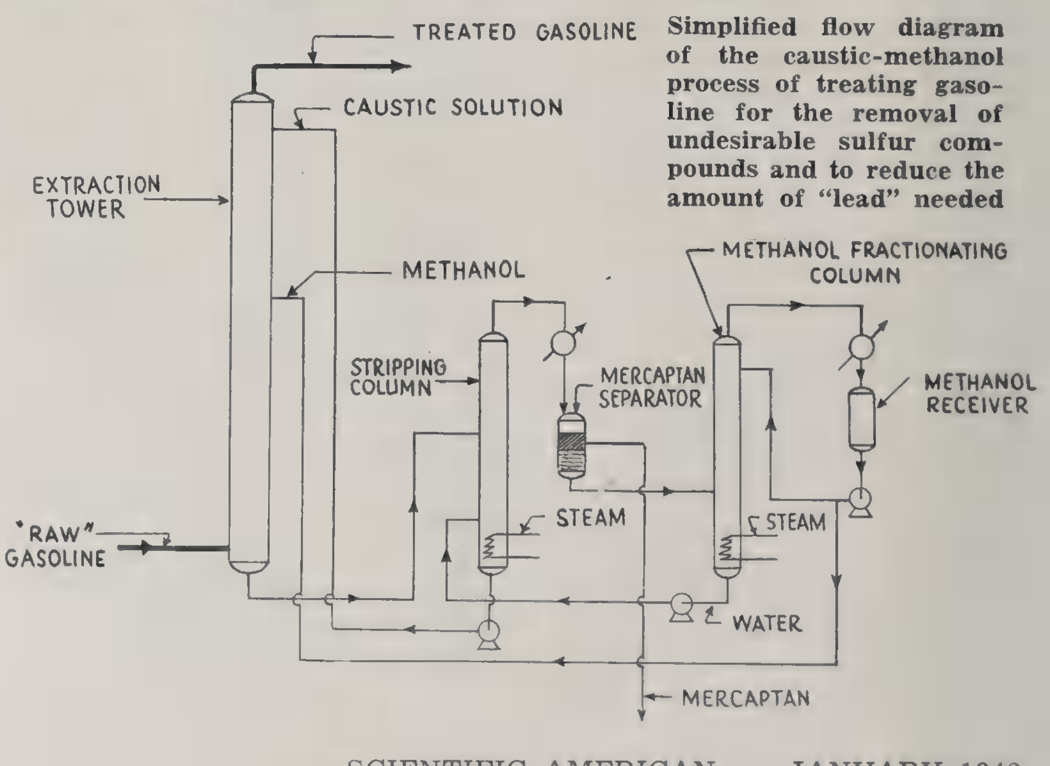
INDUSTRIAL pioneering in the petroleum field has led to the development of a new method of purifying "raw" gasoline and rendering it more susceptible to treatment to improve its anti-knock qualities. Raw, or unfinished, gasoline, as produced from crude petroleum, either by straight distillation or by the cracking process, contains malodorous compounds known to the chemist as mercaptans. These mercaptans are chemical compounds of sulfur, and are usually found in crude oil; they have such an obnoxious odor that practically all refiners have, in the past, resorted to treating operations involving the use of lead oxide and caustic soda—the so-called "Doctor Treating" — which converts these mercaptans to relatively odorless substances, hydrocarbon disulfides. This treating procedure was expensive; moreover, the mercaptans were simply converted into other sulfur compounds. The objectionable substances were not removed. Furthermore, both the mercaptans and the products into which they are converted have been known for several years to have a deleterious effect on the anti-knock value of gasoline and to interfere to a serious extent with the beneficial effect of substances such as tetraethyl lead, which are added to gasoline to improve its anti-knock value.

In spite of the rapid and widespread "face lifting" which has taken place in refinery processing methods in the last decade, the naptha-treating plant has undergone little basic change by the onslaught of new technique and, in many plants, stands as an expensive citadel which successfully has resisted all development efforts. It is true that various schemes of regenerative washing have eased the treating-cost burden in many places, but these have been only partial answers to the problem; mercaptan conversion, by doctor treating or otherwise, continues today to be the predominating means of improving gasoline odor, despite the fact that the processing methods are harmful both to a fuel's octane value and its susceptibility to tetraethyl lead treatment.

THESE deleterious effects have been known for several years. Naturally, the obvious answer to the problem has been the removal of the mercaptans. That much was easy, but how to do it was something else again. Petroleum research engineers have been attacking the problem for some years. In the first place, the mercaptans in the heavier parts of gasoline have objectionable odors, but are not sufficiently soluble in a cheap reagent, such as a solution of caustic soda in water. Moreover, organic solvents, such as the alcohols either alone or in caustic-soda solution, are excessively expensive, particularly if appreciable quantities are lost in the treated naptha. Further, any solvent which removes mercaptans, will, of necessity, gradually become fouled with other substances in the gasoline, such as sulfides, sulfates, thiosulfates, phenols, thiophenols, fatty acids, and so on, unless some mechanism is provided for discharging these materials from the recirculation system without incurring excessive cost in the loss of solutions.

This looked like a large order to expect any process to fill. Fortunately, gasoline is a large-volume product of the petroleum refinery, and if a way could be found to bring about fractional savings in tetraethyl lead and octane level, these savings in the course of a year would build up into large dollar returns. This furnished the incentive for much extensive research and development work and eventually resulted in the development of the caustic-methanol process, by research engineers of The Atlantic Refining Company. This new process meets the requirements imposed by the mercaptan-removal problem in an unusually satisfactory manner and, in addition, the commercialization of the process has disclosed that the unit manufacturing costs are considerably lower than had been anticipated at the beginning of the development. This fact increases the economic incentive for the installation of the process, and, as a result, large plant installations are now being designed.

Research in the development of the process involved almost endless studies of gasolines, the mercaptans, and other substances which contaminate motor fuels, both alone and in mixture with various strength solutions of caustic soda in water. Before the process could be perfected, the investigation was extended to include balancing the costs of the solvents which were

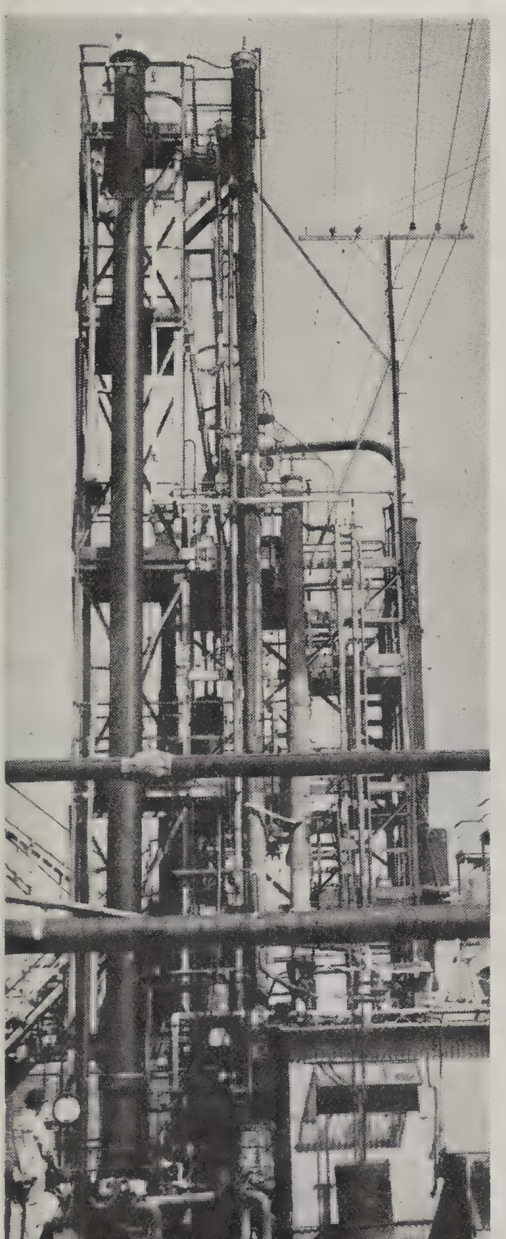


Simplified flow diagram of the caustic-methanol process of treating gasoline for the removal of undesirable sulfur compounds and to reduce the amount of "lead" needed

studied, ways and means to minimize losses in treated gasolines, the high solubility of the mercaptans, the ease with which the solvents used could be separated, and the overall flexibility of the process in treating a wide variety of raw gasolines.

Eventually, as a result of these studies, the researchers hit upon a single solution which was found to be most effective in treating the raw gasoline. It is a mixture of a solution of caustic soda in water, with methanol, or methyl alcohol. The combined solvent was found to be so effective that a substantially complete removal of the offensive mercaptans was obtained by recirculating in the plant an amount of "dry-cleaning" solvent which was less than 3 percent of the volume of the gasoline treated.

As soon as the research work was completed, the process was put into practical operation in a semi-commercial plant having a treating capacity up to 15,000 gallons per day. The operation of this plant is illustrated in simplified flow diagram in the accompanying drawing.



Semi-commercial treating plant

RAW gasoline is pumped into the base of the extraction tower at the left and flows upward. The methanol is introduced at the middle of the tower and flows along with the gasoline. The caustic soda is pumped in at the top of the tower. The combined solvents extract the objectionable mercaptans from the gasoline. The caustic soda solution, flowing down through the upper section of the tower, also removes practically all the methanol from the purified gasoline and settles at the bottom of the tower.

The "spent" solution is then pumped from the bottom of the extraction tower to a steam-stripping tower. This includes an internal steam distillation apparatus, which distills off the methanol, the mercaptans, and some steam, thus cleaning the caustic solution so it can be used again. This is withdrawn from the bottom of the stripping tower and returned to the top of the extraction tower.

The distillate from the stripper is condensed, and the condensate separates into two layers in the receiver. The mercaptans collect in the upper layer, and are withdrawn from the system, and sent to the power house to be burned as fuel. The lower layer is a water and methanol mixture kept relatively free of mercaptans by controlling the water-methanol ratio at a point where the mercaptans are least soluble.

The water-methanol mixture drawn from the bottom of the separator is then charged into a fractional distillation apparatus. The methanol passes over and is returned to the middle section of the extraction tower. The water which is left is pumped to the caustic stripper. One of the photographs gives a general idea of the size and scale of the semi-commercial plant used for the development work.

An outstanding feature of the caustic-methanol process is the separation of the two components of the solvent and the return of the two separately to the extraction tower. The charging of the caustic soda solution to the top of the extraction tower causes this section to function admirably in the recovery of methanol. As a result, the loss of the expensive methanol is negligible.

Close-up of the extraction tower

Another important advantage of the separation of the two solvents during their regeneration for use again in the "dry-cleaning" process is the ability to control other contaminating substances which creep into the solvents. This is accomplished by bleeding out small quantities of caustic soda solution from the bottom of the stripper tower so as to control the quantities of the substances which tend to build up and foul the solvent. Extensive operation of the present plant has shown that no foreign materials build up in the methanol. As a result, it can be used indefinitely.

IT WAS also found as a result of the study of a number of solvents that any solution capable of extracting mercaptans also will extract, to some degree, any phenols which occur naturally in gasolines. Since these substances usually are good stabilizers in controlling the tendency of gasoline to oxidize, their removal is not always desirable.

The caustic-methanol process offers considerable flexibility in handling gasolines of varying phenol contents. It will be recalled

that, in the regeneration step, the methanol and mercaptans are distilled from the caustic-soda solution. This regenerated caustic solution contains phenols and other acidic components extracted from the gasoline. If the stability characteristics of the gasoline being treated are such that the final product will be better because substantially all of the acidic bodies have been removed and because a synthetic inhibitor is used, the process can be controlled accordingly. This is accomplished by discarding a caustic solution when it becomes rich in phenols (50 percent by weight). The high ratio of phenol to caustic in this type of operation results in a low consumption of caustic soda.

If, on the other hand, the nature of the gasoline being treated permits the advantageous retention of the phenols, the process can be controlled to favor this retention. This is accomplished by permitting the phenols to build up in the recycled caustic-soda solution. The carrying power of the reagent for mercaptans is not impaired by this, but the extraction of phenols from the gasoline is substantially reduced.

The use of the caustic-methanol process results in a considerable improvement in the anti-knock value of the treated gasolines. In the older processes where the mercaptans are converted to other substances which remain in the gasoline, the octane values drop as much as 0.25 to 1.0 numbers. With the new method the octane numbers of the treated products are equal to or better than those of the raw gasoline. Furthermore, the treated gasoline is greatly more susceptible to treatment with tetraethyl lead to increase its anti-knock value, offering an attractive saving in ethyl fluid in all cases. This is highly important today, with lead shortages staring industry in the face.

Editor's Note: While there are other means of achieving mercaptan removal from gasoline than that described in the foregoing article, the details of the Atlantic process are published because of the economic significance of the whole general problem. Further, the process described has advantages of low installation and operation costs, the latter largely through the use of solutions which can be regenerated and used indefinitely with little loss.

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PLASTICS PRIORITIES

Made Necessary Where Methanol is Needed

Aluminum, steel, zinc, copper, bronze, and so forth, and now plastics, have been placed on the priorities list—in particular those plastics which require formaldehyde or derivatives of methanol in their manufacture.

Formaldehyde comes from methanol. Methanol is secured in two ways—one, by the distillation of hardwood; two, from synthesis of carbon monoxide and hydrogen. It is from this latter source, synthetic methanol, that most formaldehyde used today in plastics is secured. It so happens that ammonia may also be made from methanol. Ammonia is valuable in the manufacture of explosives and many formaldehyde producers have necessarily had to change to ammonia production. In addition, it is said that methanol itself may now be used in making a super explosive. Consequently the market in formaldehyde is tight and this material is high up in the priorities list. To overcome this condition, new ammonia plants are being built and it is expected that within a short time the production of formaldehyde may return to a more normal status.—*Durez Plastic News.*

REPLACEMENTS

Developed in the Radio Manufacturing Field

As a result of the search for alternate materials in radio sets, RCA Laboratories has developed more than 40 replacement materials; one item alone has saved 148,000 pounds of aluminum in the plants of the RCA Manufacturing Company.

Aluminum was one of the first items, essential to the radio industry, affected by priorities control. In every RCA Victor radio set, aluminum cans were employed to protect intermediate transformer coils. Four millions of these cans had been used in 1940; therefore, if they could be replaced by using an alternate, a tremendous saving in aluminum would result.

A fabricated cardboard tube, coated with a moisture-resisting substance and a sheet of copper foil, was tried instead of the aluminum can; marked success was achieved. The aluminum thus saved has so far amounted to 74 tons. Another important saving of aluminum was effected by using a plastic in the record changer control segment of radio-phonographs.

Plastics are under consideration to replace the metal housing that protects loudspeaker cones in radio receivers. They can also be used in making dial faces and a number of other parts in both radio and phonograph equipment. Their possible field of application is extremely wide. But even plastics are meeting curtailment.

Thereupon, the job of finding an alternate for an alternate was started. The answer was a felted substance made from shredded wood, cardboard paper scraps, and sulfite pulp. Moulded into required forms and treated with a moisture-resisting impregnant, it proved to be as tough as either wood or plastic. It can be covered with fabricoid or other surfacing. By the use of thermofusion, metals can be bonded to it. Perfection of this substance opens up new avenues of manufacturing development.

MOVIE TRAINING

Now Available For Lathe Operators

To speed up the training of lathe operators, the South Bend Lathe Works has sponsored the production of a series of 16mm sound motion pictures in full color based on the book "How to Run a Lathe." Professionally filmed by Burton Holmes Films, Inc., at the South Bend Lathe Factory, these pictures show practical shop methods as practiced in modern industrial plants. Showing time for each of the two 800-foot reels now completed is approximately 20 minutes.

The first reel, entitled "The Lathe," clearly shows the apprentice what a lathe is, what a lathe is for, and how the various parts operate. Important lathe opera-

tions, including turning, facing, and thread cutting, are demonstrated. The second reel, "Plain Turning," shows in detail each operation performed in the machining of a straight cylindrical shaft between the lathe centers. Close-ups show locating and drilling of center holes, adjustment and setting of cutting tools, use of cross-feed graduations, use of calipers and micrometers, use of quick-change gear box, changing speeds, and operation of the lathe carriage and apron.

Factory apprentice schools, vocational schools, Army and Navy training schools, colleges and high schools teaching machine shop practice will find these films helpful in training lathe operators. Complete information on securing the use of these films can be had by writing to South Bend Lathe Works, Dept. S7, South Bend, Indiana.

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EYES—In round figures, eye accidents cost American industry at least $50,000,000 annually in lost time, medical expenses, and compensation. The average cost for an industrial eye injury is $343, as compared with $194 for all other types of occupational accidents.

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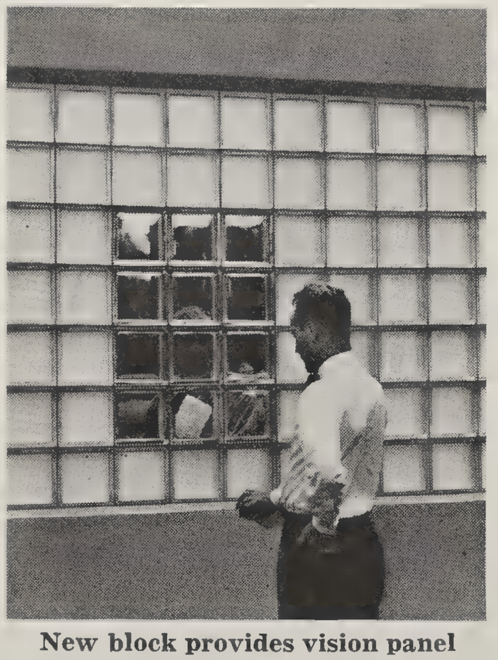
TRANSPARENT

Glass Building Block Provides Vision

A TRANSPARENT glass building block that affords almost window-like vision has been developed by the Pittsburgh Corning Corporation, a jointly owned subsidiary of the Pittsburgh Plate Glass Company and the Corning Glass Works.

The new block, called the "Vue" glass block, was developed for specific needs where some outside vision is desired through panels of non-transparent glass blocks. The new block permits sufficient general vision of large objects or movements beyond the panel to prevent a "shut-in" feeling, although the visibility of sharp detail is not possible under most conditions. The Vue block combines the high insulation properties of the usual glass block; it contains a partial vacuum, a dead air space, which results in the glass block panel having approximately the same insulation value as a solid masonry wall eight inches thick, and more than twice the insulation value of ordinary single-glazed windows.

In factories where non-transparent blocks have been used in exterior walls, a common custom has been to install several rows of transparent window glass panes. Several courses of Vue blocks might very well be combined with a selected conventional glass block pattern to achieve approximately the same light transmission and visional properties, but with the added advantage of better insulation.



New block provides vision panel

In certain instances, workmen in factories where all light-transmitting areas are of obscure glass, or where plants are windowless, have indicated a mild feeling of claustrophobia. This shut-in feeling could be alleviated by the use of a few of the new blocks inserted in the center of the large glass block areas to provide a vision panel.

ROSIN

Increased Production and Use of Derivatives

ROSIN derivatives, now used in lacquers and paints, plastics, roofing, floor tile, and the box toes of men's and women's shoes—many of these being entirely new uses—are to be produced in large quantities in a new plant of the Hercules Powder Company, now in operation in Hattiesburg, Mississippi.

The new plant will use molten rosin delivered to it by pipeline from the adjoining Hercules naval stores plant, eliminating the packing, cooling, shipping, and remelting normally required in handling rosin. Another reason for locating the plant at Hattiesburg is that large supplies of hydrogen, used in the manufacture of the chemicals, can be obtained from natural gas available in the Louisiana and Mississippi oil fields.

"The series of rosin esters which this plant will produce will help diversify the rosin producer's market," a company report states, "for substantial quantities of these esters are already used by industries which have never used rosins before. An industry sending its products into many varied industries where they serve a multitude of purposes can only gain from technological progress. In fact, by furthering chemical research, it can both serve industrial needs and benefit by the greater use for its own products. This purpose has motivated the Hercules program of fundamental research on rosin derivatives."

• • •

CHAINED: Defense workers are being chained to machines by the wrist—but as a safety measure. The wrist device, called the Posson guard, uses a pull cord attached to the machine which prevents the worker from getting his hands or arms into the mechanism when it is in operation.

• • •

INDUSTRIAL AID

Supplied by Available Chemical Engineers

AN INCREASING number of manufacturers are finding it impossible to secure certain raw materials for the operation of civilian supply industries, and are attempting to turn to the production of usable merchandise made from raw materials that are not subject to priorities. In many such cases, however, technical problems arise which the manufacturers are unable to solve with available facilities. To meet this crisis these manufacturers have to avail themselves of independent consulting chemists and chemical engineers, often difficult to locate.

Manufacturers who find themselves in this predicament will be referred to an association where they can obtain free listings of consultants for such chemical problems, if they will address the Editor of Scientific American, stating their needs briefly.

INDUSTRIAL TRENDS

INDUSTRY LEARNS FROM DEFENSE

Many of the lessons that American industry is learning under the forced draft of national defense production are going to have a very definite effect on the general trends of all industries in the immediate future as well as in the time of peace which will ensue. Any consideration of these lessons cannot stray far from the automobile and aviation fields, since it is in these industries that the greatest effort is being made to press production to the limit in providing the means for transporting huge numbers of men and vast quantities of materiel for military purposes. But, although consideration centers in these two closely linked industries, implications of developments accomplished and still in the formative stage are spreading and will continue to spread into all industries however remote from the centers of automotive production.

Outstanding example of technological progress in aircraft engine building, fostered by the laboratories of the automobile industry, is the production of cylinders from castings instead of forgings. When time was of little moment in airplane engine construction, the individual cylinders were machined from large forgings often weighing up to 100 pounds, for the production of a unit that, finished, would weigh only 15 pounds or so. Here was tremendous lost motion, lost time, inefficient use of material. Then came the contribution of centrifugal casting, by which were produced cylinder castings weighing only about 20 pounds and which needed only a minimum of machining to produce finished units. Time, material, machines, and manpower needed for the job were reduced, production was stepped up.

One word in the preceding paragraph holds the key to the success of cast cylinders—"centrifugal." Automobile engines have, of course, been made almost universally with cast cylinder blocks. But in a motorcar engine, low weight is of little consequence; in an aircraft engine it is essential that weight per horsepower be kept to the lowest minimum. Castings made by conventional processes cannot be machined to thin sections; to do so results in reduced strength. Thin sections in cylinders are required in aircraft engines to reduce weight; hence the use of forgings in the past. Automobile engineers, however, always unconventional, developed the centrifugal casting method to a point where it could produce cylinder units sufficiently strong to be machined to thin sections, and the problem was solved.

Obviously this casting method, which spells success for high-speed production of aircraft engines, will not be confined to the automotive field. There are many places in industry where it will find wide use in many applications, replacing forgings in some cases, developing new products in others. Together with powder metallurgy, this latest trend in the development of methods of producing a variety of shapes from metal will undoubtedly take a place of outstanding importance in the industrial world.

Another example of the effect which the automobile industry is having on the production of airplanes is to be found in the efficient utilization of multiple drill units for high-speed work. Where many hours were formerly spent in drilling holes in the main framework of a certain engine, the time required has been reduced to a few minutes more than one hour. Again, a number of machines labored for an hour to drill the required holes in an engine cylinder; time required on the job after automobile engineers tackled the problem was only three minutes—and this was accomplished with a smaller number of machines than was formerly used.

It stands to reason that these lessons of efficient machine utilization, just as in the case of centrifugal casting, are not going to be confined to any one or two industries. Engineers are finding that methods peculiar to one type of work can often be applied to other fields with equal success. And under present stimulus these applications are being ferreted out and developed to the benefit of all.

From what has been said above it must not be assumed that this automobile-airplane co-operation is all one sided. While motor-car engineers are contributing mightily to speeding-up aircraft production, they are also, in turn, learning lessons from the technicians of the aircraft industry. High-octane fuels, long used in airplanes, require special engine design of the sort that is meat for the aircraft men; automobile technicians are devouring the details of these designs and it is no shot in the dark to state that, beyond doubt, high-octane fuel will be used in the motor-cars of the future, with engines that will utilize it efficiently.

Then there are the techniques of using lightweight materials, special alloys, high-strength construction, and so on which have been brought to a fine point of perfection in aircraft work and can be applied to automobile design with decided advantages.

Such facts as have been set forth in the limited space available here give strength to the statement that there is certainly a bright industrial side to the grim business of preparing for national defense; the lessons learned by industry as a whole are leading rapidly toward more efficient use of available materials and the development of alternate materials to bolster or replace those of our natural resources which are limited in quantity or more urgently needed for other purposes.

SYNTHETICS NOT ALWAYS SUBSTITUTES

Not all research in synthetic-rubber is being directed toward replacement of the natural product. In fact, many uses for materials that are emerging in a steady stream from the synthetic-rubber laboratories are being found where rubber had never been considered before. Thus a new non-metallic synthetic has been produced by the United States Rubber Company that is only one third as heavy as aluminum and will release much of that metal for other purposes. Upon impact of bullet or shell, it resists shattering, it does not fatigue as do some metals when subjected to vibration, it does not corrode. All these qualities point toward a promising future for this synthetic, so far known only as C-102. Industry will be quick to find use for a material of this kind.

—*The Editors*

OUR *Point* OF VIEW

TELESCOPTICAL CANFIELD

Elsewhere in this number is the first part of an article by the scientist in immediate charge of the 200-inch telescope mirror being built in California. Nowhere does he answer the one question which everyone asks: "When will the mirror be finished?"

A probable reason for this omission is that he doesn't know, and a still more categorical answer is that, literally, nobody does. Yet no inquirer—at least no real American United States Yankee—has ever accepted this answer lying down. All inquirers, when told that nobody knows, come straight back with something like: "But when?" Or, "If you don't, where can I find out?" Or, "When do they think it will be finished?" It is as if they suspected one knew all along, and determined that they would somehow mine it out of you.

It isn't the "grinding"—to use a term by which those who have never tried the work usually designate the whole process. It isn't even in the polishing that follows the grinding. It is the final operation called figuring, and which involves alterations seldom deeper than hundred thousandths of an inch and usually only millionths of an inch, that contains the real grief, the big headache.

Short of accidents, the concavity can be roughed out with coarse abrasive grains and smoothed to the satiny finish of fine-ground glass with finer and finer grains, working to a predictable time schedule. Polishing with rouge is similar in this respect.

In the next and final stage comes work that is art, not mechanics alone. Here and there millionths of an inch of glass thickness must be shaved off with local tools. Here predictability ends. Too much may be shaved off. Or some may be shaved off in the wrong place. The work must then be done over again. Often this going back is repeated over and over again. The object of the game is to do it times enough so that, ultimately, all the parts of the mirror's surface will come out right at the same time, with no areas too high or too low.

Seeking for a comparison that will "register" with the reader who never has tried this game even on a small mirror (where the principles are much the same) the game of Canfield comes to mind. You get almost through and find you can't come out. Start all over again. Maybe do this several times. This sort of thing largely gives the answer to the question, "Why can't they say when the mirror will be done." It's a game. A month? A year? Longer?—*A.G.I.*

RESEARCH AND LABOR

Great as have been the contributions of research—both pure and applied—to industrial development, there still appears to be wide-spread misunderstanding about the ultimate aims of the research laboratory. This is particularly true in the case of labor, where failure to appreciate the value of research results in a feeling of antagonism that frequently takes somewhat this form: "Those guys in the laboratory have it pretty soft. All they do is play around all day and draw good money. Me, I work like a dog and hardly get enough to live."

All of which goes back to the age-old battle between labor and so-called labor-saving machinery. For generations every mechanical development that resulted in apparent labor replacement has been bitterly opposed by just that group of workers which eventually reaped the greatest benefits. And the research laboratory of today is the birthplace of the fundamentals that are to become the mechanical improvements of tomorrow which, in turn, will benefit directly the man in the shop who may now be grumbling about "the guys in the laboratory."

As is perfectly obvious to anyone who follows even casually the course of science and industry, work in any sort of research laboratory cannot follow the well-defined lines of, for example, production operations on lathes or punch presses; on paper-making machines or in steel mills. The industrial workers have a carefully planned system of production that is followed throughout the working day; the laboratory technician conducting research is doing just what the name implies—searching for something, and that search, to the uninitiated, may very well appear to be aimless play. Hence there is a perfectly valid reason—in his own eyes—why the laborer should hold the research scientist in scorn.

Knowing full well that this state of affairs exists, it is indeed refreshing to hear of a representative of labor who has sufficient knowledge of the industrial world, and the right sort of intestinal fortitude, to make the following statement:

"The wages that workers in the pulp and paper industry now earn could not have been paid 25 or 30 years ago, no matter how strong the unions might have been, what their form of organization might have been (craft or industrial), or what labor legislation might have existed on the statute books.

"The pulp and paper industry is able to pay higher wages today because of improved methods of production which enable the mills to produce more paper at less cost than ever before. The contributions of enlightened management, engineers, technicians, and chemists in developing this great industry must not be overlooked or minimized as a factor responsible for the higher standard of living that the pulp and paper workers now enjoy." This quotation is from John P. Burke, president-secretary of the International Brotherhood of Pulp, Sulphite, and Paper Mill Workers.

Management, engineers, technicians, chemists—a complete research team: Labor receiving its share of the results of increased production and efficiency. Which is the way it happens in real life, despite any appearance of "play" on the part of the research worker.—*A.P.P.*

Molecular Spectra

More Complicated than the Spectra of Atoms, They Also Tell us More

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

SEVERAL interesting recent papers, dealing with the composition of bodies of astronomical interest, have this in common: they depend upon observations of molecular spectra.

Molecules are quite as capable as isolated atoms of emitting or absorbing spectra. These spectra are more complicated than those produced by atoms, but for that very reason, when they are well understood, they give us more information.

The lines of a given atom—such as iron — are usually scattered along the spectrum with apparent irregularity, though intricate and accurate relations between their positions are revealed by thorough analysis. But in a typical molecular spectrum, the very numerous lines are obviously arranged in groups. At certain places they crowd together so closely that spectroscopes of the highest power are required to separate them. On one side of such a "band head" the lines are sparse, while on the other they are numerous, gradually increasing in separation and growing fainter, and forming a "tail." Head and tail are parts of the same structure—the head being the region where the lines are most closely crowded. With spectroscopes of low power, the separate lines are not resolved and the band appears continuous, shading away gradually from a sharp edge on one side. Often the head of a second band is superposed on the tail of a first, and so on, producing very complicated patterns.

What happens in a molecule when such a spectrum is emitted, is now well understood. But, even in the simplest case of a molecule composed of only two atoms, the possibilities are much more varied than for a single atom. In the latter case, an electron can be shifted from its normal state in the atom to another state, or fall back again, with absorption or emission of radiation of a definite wavelength —a spectral line. There are many kinds of these electron-jumps, and so many lines in the spectrum. The same thing can happen in a molecule, but other things may, too. The two atoms (more precisely their heavy nuclei) will, in the normal state of the molecule, rest in stable equilibrium at a certain distance apart. If farther apart, they attract one another; if they are closer, they repel one another. Hence, if they are disturbed from the standard position, they will oscillate about it with distance alternately less and greater. Moreover, the molecule as a whole, whether the atoms are at their standard distance or oscillating, may be rotating about its center of gravity.

THESE motions, like all others that occur in structures of atomic dimensions, are governed by the quantum laws. There are a series of possible states of vibration which may be numbered 0, 1, 2, 3 . . . with amplitude increasing from each to the next, and a similar series of permitted states of rotation at increasing rates—usually very numerous.

The molecule can change from one to another of these states—according to certain rules. For example, the quantum-number defining the rotation changes by one unit. An electron-jump, a change in oscillation, and a change in rotation can all occur at once. No wonder the spectra are complicated! Changes in the rotation alone (which involve very little change in energy) give radiations in the remote infra-red. Changes in oscillation and rotation together usually produce bands in the nearer infra-red, and an electron-jump is usually required to get a big enough energy change to put the bands in the visible region.

With the same electron-jump and vibration-change, different changes in rotation (as for 0 to 1, 1 to 2, 2 to 3, and so on) produce lines very close together, the separate members of a band. A different change in vibration-numbers gives another band. The bands corresponding to such changes as 0 to 0, 1 to 1, 2 to 2, are often so close together that they tread on each others' tails, while 0 to 1, 1 to 2, and similar changes give another band-group, and so on. Thus we get a complicated band-system, which may fill a long range of the spectrum with thousands of lines, all from the same electron-jump. Another jump gives a different system of bands; —and finally, if the molecule is ionized, an entirely different set of systems of bands will result. Molecules containing three or more atoms give still more complex spectra.

BAND-SPECTRA are peculiarly characteristic of comets. The gases which form the head and tail escape from the solid particles of the nucleus and are set shining by absorption of energy from sunlight. The molecules C_2, CN, CH, CO^+, and N_2^+ have been recognized for many years. All five of them are fragments of the stabler molecules ordinarily known in the laboratory—the last two having lost an electron. Why the more familiar molecules do not show up is simple—their strong bands lie in the far ultra-violet, to which the Earth's atmosphere is opaque. We know, too, why the observed bands appear. They are all "resonance bands." A molecule of C_2, for example, in its normal state can absorb some line from sunlight, and become loaded with energy. Returning to normal, it emits this energy as light of the same wavelength. Other molecules, at the same moment, are working on other lines; so when we see the comet against a dark background, all the lines of the system appear bright. Once returned to the ground-state, the molecule can absorb again. Hence a relatively small number of molecules working steadily will give off a considerable amount of light.

Cunningham's Comet of last autumn, though not of the first rank, was bright enough to be observable with fairly high dispersion, and a long series of spec-

trograms were obtained by Swings, Elvey, and Babcock at the McDonald Observatory. These extend much farther toward the ultra-violet than any earlier observations, and thus reveal the presence of two more molecules, OH and NH, with bands near 3100 and 3360 angstroms. Like the others, these are fragmentary molecules, and the bands are resonance bands. From chemical considerations, we might expect these molecules to be present, since others containing hydrogen, oxygen, and nitrogen are. The strength of the bands indicates that they are abundant.

The cyanogen bands are extensively developed. Comparison of these bands with those produced in emission in the arc, or in absorption in the Sun, shows that the lines corresponding to the more slowly rotating states of the molecule are strong, while those produced by the rapidly rotating states are weak, or absent. That is, the average rate of rotation of a cyanogen molecule in the comet is very much smaller than in the arc or the Sun. The same is true of NH, OH, and CH.

In a gas of ordinary density, where the molecules collide with one another, very often the energy of rotation (of a diatomic molecule) will average two thirds as great as that of its forward motion, so that, at high temperatures, the high rotational states will be well populated. In a cool gas the slowly rotating states will be favored.

The density in a comet, even in the head, is so low that practically no collisions between molecules occur, but we can still speak of a "rotation temperature," such that in a gas of ordinary density the average rotation of the molecules would have the known value. The cyanogen bands in this comet show a preference for the rotational states which correspond to a temperature of 300 degrees absolute (about room temperature), and also a second group of lines indicating a slower rotation, such as would be found at 50 degrees absolute—much colder than liquid air.

If the density were not so excessively low, it would be impossible for two groups of molecules rotating at such different average rates to remain distinct. As things are, the observers suggest that the molecules of CN may be produced by two different processes of dissociation of parent molecules (such as would originally escape from the solid particles of the head), and that one of these processes sets them in more rapid rotation than the other.

If these molecules were left entirely to themselves, their rotation would slow down to almost nothing; for a transition from one state of pure rotation to a slower one, with emission of radiation of very long wavelength, is possible under the quantum rules for any molecule composed of unlike atoms. What prevents this from happening appears to be the absorption of sunlight by the molecule. This tends, on the average, to increase the rotational energy, and may undo the first effect, or strike a balance where the two compensate one another.

This reasoning explains also what would otherwise be very puzzling. The carbon bands, produced by the C_2 molecule, show evidence of many rapidly rotating molecules, corresponding to a rotation temperature of 3000 degrees. But this molecule, being composed of two identical atoms, cannot unload its energy by the "pure rotational" transitions — they are forbidden by the quantum laws. Hence, the absorption of sunlight would gradually build up the average rate of rotation to a high level.

There remains a fairly conspicuous group of lines or narrow bands in the violet (between 3980 and 4130 A) which has not yet been identified and presents one of the last unsolved problems of astronomical spectroscopy.

While this remains a mystery, another important problem has just been solved. We have spoken before in these columns of the interstellar lines which are absorbed by atoms scattered with extreme sparseness in the depths of space remote from the stars. Besides atoms of sodium, potassium, calcium, titanium, and iron, the familiar molecules CN and CH have been identified — but by very curious-looking spectra. During the extremely long times of isolation in interstellar space, a rotating and oscillating molecule has time to make the transition, step by step, to lower states. Being free from stimulation by near-by stars, such molecules should practically all be in the rock-bottom ground-state of lowest energy, beyond which it is not possible to go. A molecule in such a state can absorb but one, or at most two or three, of the lines in the corresponding band — so that a whole complex band-system containing thousands of lines will be reduced to one line where each of a group of many-lined bands is normally found. These lines, moreover, correspond to a transition from the state of lowest possible rotation to the next, and are usually faint in comparison to other lines of the band, corresponding to more rapid rotation. A thorough analysis of the bands, however, points with certainty to the particular line in question.

After these highly simplified spectra had been identified, four sharp interstellar lines remained. Discussion of these at a conference on interstellar molecules at the Yerkes Observatory led to the suggestion that three of them (with wavelengths 4232.58, 3957.72, and 3745.33), which were spaced about as the residual lines of three band-groups might be expected to be, might arise from some ionized molecule, such as CH^+ or C_2^+. Returning to the University of Saskatchewan, Dr. Herzberg, with his colleague, Dr. Douglas, proceeded to make molecules of this sort by the effective method of passing a discharge through helium containing a trace of the vapor of benzene, C_6H_6 — a heavy molecule which can be broken up into all sorts of pieces. Three new bands appeared in the spectrum, with heads at 4225, 3954, and 3743. The individual "rotational" lines in these bands were widely spaced, a proof that they come from some very light molecule — indeed, from one containing a hydrogen atom. Analysis of the structure served to identify the residual lines of the three bands, which were at 4232.57, 3957.71, 3745.30 — agreeing within the errors of measurement with all three interstellar lines. More detailed study of the bands showed that they were of a type which could be produced only by CH^+ among those molecules whose spectra were not already known.

As neutral CH molecules were already known in interstellar space, the presence of such molecules in the ionized state might have been anticipated. Only one sharp interstellar line at 3579.04 remains unidentified. The chance that it may turn out to belong to some other ionized molecule now looks good.—*Princeton University Observatory.*

How They Do It

By Prestidigitation, Dunninger Duplicates "Phenomena" that have Fooled the Public

These knots disappeared

On the evening of November 10, 1941, members of the Scientific American Committee for the investigation of Psychic Phenomena, their guests, and representatives of the press assembled in a room in the Waldorf-Astoria hotel, in New York City. The purpose of the meeting was educational, for Dunninger, Chairman of our Committee, proposed to produce some of the more noteworthy "phenomena" he has witnessed during his more than a score of years as researcher in the realm of the occult. In duplicating these so-called psychic spectacles, two purposes were accomplished. The extent to which modern conjuration may offer delusion and deception was demonstrated, and bogus mediums, who have presented — and who still present — "phenomena" which are demonstrably hocus-pocus, and by which the public is annually bilked of an estimated 50 million dollars, were exposed. That legerdemain, prestidigitation, and certain types of mechanical artifices performed by and in the hands of a clever operator can completely bemuse an audience of higher than average mental caliber was conclusively proved at this meeting.

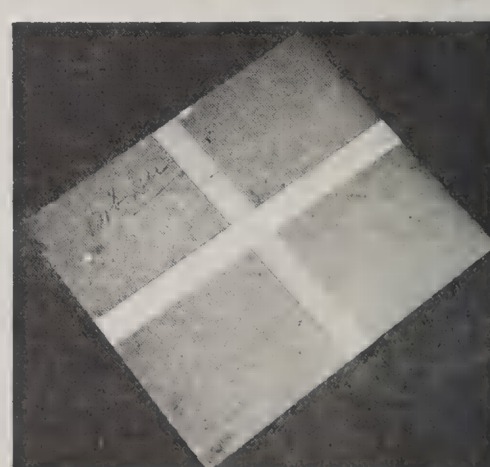
Our Chairman, one must remember, has been practicing the arts of deception for many years; furthermore, in the course of his investigatory work into psychic matters, first with Houdini and later on his own behalf, he has witnessed over 1000 so-called occult demonstrations of physical nature, all of which must be accepted as pseudo, for Dunninger has successfully duplicated by trickery or explained by natural means all of the "phenomena" that have thus far been brought to his attention. However, this must not be taken as an indication that either the Chairman or the members of our Committee are engaged in a "witch hunt." Far from it. Since the advent of Spiritualism in its present form, about 1848, too many unexplainable incidents have come to public attention to dismiss lightly, and as pure hokum, the theory of return to earth after death. If our Committee, individually or collectively, were of that mind, there would have been no need or excuse for the original organization of that body. To the contrary, and notwithstanding all other claims, the inquiry of the Scientific American Committee in the field of the supernatural in no sense questions any form of religious belief, nor does it seek to cast aspersions on any individual or group who may lay claim to super-normal powers. The indisputable truth about psychic matters is the aim of the Committee, but, by the same token, no credit or mercy can be extended to mediums or others whose practices are clearly shown to be nefarious and therefore not in accord with public welfare.

Dunninger; Miss Jane Schuele

To emphasize how trickery can be utilized, Dunninger called two members of the audience to the platform and asked them to tie a number of simple knots simultaneously in two pieces of rope. While this was being done, he explained that Madame Stewart, a noted medium from Cleveland, Ohio, had based her claims to supernatural powers on ability to untie knots *in the dark*, while attendants at the seances held the four ends of the two ropes. In a room flooded with light, two men chosen at random from the audience each held two ends of the dual ropes while the magician proceeded to untie them. Never once did the ends of the rope leave the hands of the witnesses.

To assist in his next demonstration, the Chairman requested a young lady, Miss Jane Schuele, to be seated at a small table opposite him on the platform, with her back to the audience. He displayed a stack of ten small slates, which were placed on the table. He then asked Miss Schuele to write on a slate the name of a deceased friend or relative and the date of the demise. This she did in such a manner that no one could see what had been written and then laid the slate, writing side down, on top of the pile. Dunninger picked up what he termed his "concentration slate," a larger edition of the one Miss Schuele had used, and placed it over the top of the stack of slates. Drawing a chalk line on the large slate, he termed this "the concentration line." Leaning back in his chair, he lifted his "concentration slate" from the pile of smaller ones and gazed at it, meanwhile requesting Miss Schuele to concentrate as intensely as possible on the chalk line. Without hesitation, he then gave the name that had been written on the smaller slate and the date of that person's death.

This was temporarily mystifying, but when the Chairman changed



The cards are tied together

places with Miss Schuele at the table and repeated the trick, asking the young lady for a different name and date, the audience saw clearly how the apparently amazing effect was so simply accomplished. As the magician leaned back in his chair and picked up the "concentration slate," he also picked up the top one of the smaller slates — the one with the message on it. This was easily done, for the inner edges of the frame of the "concentration slate" were made to fit perfectly around the outer edges of the slate which bore the message. As that slate had been placed message-side down on top of the pile, the writing appeared to the manipulator when picked up simultaneously with the "concentration slate," but not to Miss Schuele, nor, in the first instance, to the audience.

THE term "independent writing" has in modern times been applied to many forms of supposedly mysterious appearances of writing on a slate or a piece of paper, and various methods and rituals are used in the course of its production. (July and August 1941). To demonstrate one of these, Dunninger called two representatives of the press to the platform. They were Mr. Robert Dunn, of *King Features,* and Mr. Phil Hamburger, of *The New Yorker.* Handing each man a piece of ordinary cardboard about six by nine inches, he asked them to sign their names on one side of their cardboard. Then, to insure that the witnesses would see *both* sides of the cards before and after the trick was completed, he had them exchange cards and autograph the remaining blank sides, which left a Dunn and a Hamburger signature on either side of each card. After the cards

Suspended before all eyes

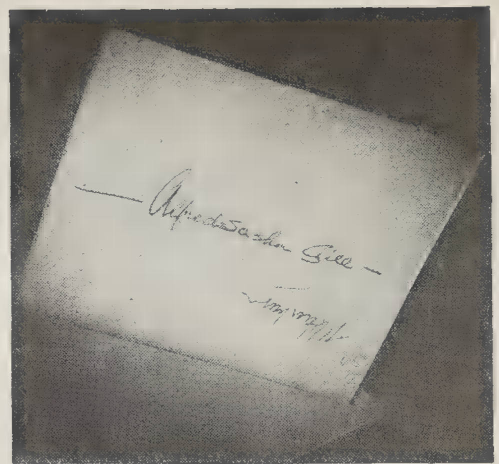
were given to the two men for signature, Dunninger did not handle them. The witnesses placed the cards together, tied them with a ribbon and placed them in a strong box provided by a member of our Committee. They locked the box and retained the key. The strong box, without being touched by Dunninger, was securely taped, hooked to a rope which was thrown over the top of a 9-foot screen, and hauled up in plain view of the audience, where it remained for approximately an hour while other demonstrations were presented.

For the denouement of this trick, a New York telephone book for the borough of Manhattan was utilized. Dunninger asked a member of the audience to open the book at random. The magician held the book spread out at the designated page, requested another member of the

Messrs. Dunn and Hamburger examine the names, find Gill's

audience to take pencil in hand and, by making a circular motion, to mark any name on the two open pages. The man revolved his pencil several times in mid-air, then brought the point down. It came to rest on the name of Alfred Sasha Gill. The name was read from the book by the witness and underscored so that others might corroborate his statement.

Messrs. Dunn and Hamburger were now recalled to the platform. Together they removed the strong box from the rope, tore off the tape, and unlocked the box, which at no time was touched by Dunninger. Somewhat gingerly, as though fearful of what they might find, the witnesses removed the cards, still fastened together by the ribbon, which they now untied. Each quickly looked at his card to determine whether the names were still there. Not only were the two



From 'phone book to card

names present, written in ink, but also, scrawled in heavy black pencil on one card was the name — Alfred Sasha Gill! For the sake of emphasis, it must once more be repeated that after handing the cards to Messrs. Dunn and Hamburger for their signatures at the beginning of the trick, Dunninger did not lay hands on them again, yet the name of Alfred Sasha Gill, chosen from the telephone book by a third and independent witness, after a fourth had blindly selected the page, was clearly apparent to all.

AS EVERYONE present knew, and as Dunninger forcefully stated, each of these "phenomena" had been accomplished solely by trickery, motivated by digital dexterity acquired through years of assiduous practice. Performed by a man who, among other accomplishments, is admittedly a magician, they were breath-taking, interesting, and entertaining. But, those identical feats of legerdemain, presented under the spell of darkness, or soft lighting — possibly with a subdued musical accompaniment and the intriguing odor of incense permeating the room — have been called "psychic manifestations" by the medium conducting the seance. With that sort of bogus performance, our Committee has no patience. We still, however, seek the truth concerning the physical type of psychic phenomena, and welcome all sincere offers of assistance and information.

● Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. ●

Dr. Carrel's Immortal Chicken Heart

Present, Authentic Facts about This Oft-Falsified Scientific "Celebrity"

ALBERT H. EBELING, M.D.
Lederle Laboratories, Inc.

A TINY fragment, removed in 1912 from the heart of an unhatched chick embryo by the eminent Dr. Alexis Carrel, began then the most extraordinary career ever enjoyed by a chick or a part of a chick. It has attained potential immortality. The present descendants of the cells in this fragment, now spoken of as Carrel's immortal chicken tissue, or the "old strain," are in their 30th year of independent life in the wholly artificial environment of laboratory glassware. Their growth is independent of time. Under the established conditions, the cells do not grow old, and now, after practically three times the lifetime of a normal chicken, they are as young and healthy as ever.

The Carrel tissue, and others similarly cultivated, daily perform important services to advancing medical science. Independently growing cells, able to convert nutrients into new cells of their own kind, possess unique value as reagents for investigating biological problems. They are released from the natural defenses that protect organisms and hence respond freely to changes in their environment.

The scientifically important researches conducted with the "old strain" have filled volumes of reports. Among them, for example, have been studies of changes in environment on cell growth and cell characteristics. It has been found that blood plasma, included in the tissue culture medium, exerts an effect on the rate of growth of the cells varying with the age of the animal supplying it. Thus changes accompanying aging have been studied.

The history of the "old strain" is closely bound up with the progressive development of tissue culture technique as carried out in Dr. Carrel's laboratory. The procedures are used in the cultivation of numerous pure strains of cell types other than the original "immortal chicken tissue" of Carrel, such as, for example, various types of epithelial cells, cartilage, thyroid, liver, certain cell types from the blood as well as various strains of malignant cells (sarcoma and carcinoma), in a known condition of activity and on media of almost unvarying composition.

Lederle Laboratories photo

This is *it*—the famous culture as it is kept

One important use of tissue culture is in the study of the mysterious viruses, potent causes of many diseases—among others, influenza, measles, and poliomyelitis (infantile paralysis) in man, and distemper, rabies, and encephalomyelitis in animals. Viruses, so far as is now known, will grow only in the presence of living cells. In ordinary living tissue the native defenses of the organism against external harm affect the growth of viruses. Consequently a controlled environment must be created to permit their cultivation for study. That situation exists for certain viruses in tissue cultures. A few viruses will grow in the pure strain of the original Carrel tissue. Others require the favorable environment of cultures of other tissues grown by the technique developed by Carrel.

The many years the cells of the "old strain" have been under cultivation and the constant conditions under which they are maintained cause them to grow steadily, independent of time. They multiply—proliferate—at an unchanging rate, and their characteristics are well known and invariable. Their long pedigree and the mass of information accumulated about them in nearly 30 years make these cells the best possible material for testing the effects of a large number of substances of clinical and commercial value. For example, with them much can be learned about the action of drugs, such as those of the sulfanilamide family, upon living tissue. Similarly, they provide a unique way of studying the antiseptic action of germicidal compounds. To be a safe antiseptic, a substance must be more toxic to bacteria than to the healthy tissue of the wound to which it is to be applied. This is not true of many germicides. The all-important toxicity ratio — the dilution of a substance required to kill a standard bacterial culture, compared with the dilution that kills a culture of tissue cells—can be directly and accurately determined with this tissue. The standard strain is being widely used in tests of this sort at Lederle Laboratories and has already thus "earned its keep" over and over again.

Although this tissue's history is sufficiently impressive without embellishment, legends, some of them fantastic, have grown up about it. In these tales Dr. Carrel's original tiny fragment of chick embryo heart-tissue has grown into a large, pulsating chicken heart; or pieces have to be "snipped off" from time to time to hold it in bounds; or it is being kept in a glass jar or on a white marble slab, with the added setting of a group of scientists crowded around intently watching and tending it constantly, day and night!

YET, even though the simple facts lack some of the drama of the legends, they are important and no less interesting. On January 17, 1912, a minute piece of heart muscle was removed from an unhatched chick embryo. This tiny fragment, during repeated transfers into fresh nutrient medium, pulsated for a little over one hun-

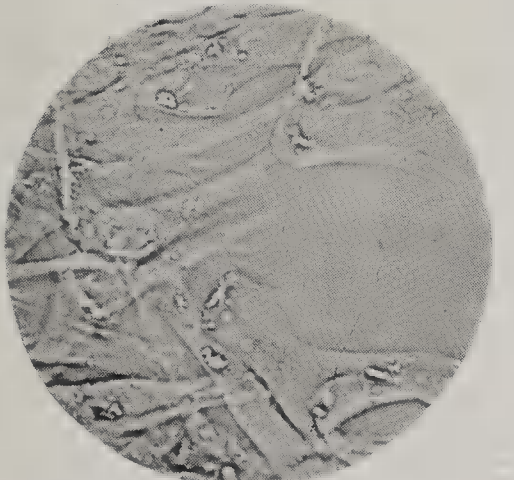
dred days after its separation from the orginal heart. By that time connective tissue cells—fibroblasts—which also were present in the original fragment, had gradually outgrown the muscle cells. The result therefore was ultimately a pure strain of fibroblasts, which pulsed no more. These cells have the property of continuing to form a network of tissue in a wholly artificial environment, not as part of a chick.

They multiply today as actively as they did at the beginning of their artificial life. The rate of growth has not diminished and they are constantly maintained under conditions favoring their optimum multiplication.

THE strain of cells is now in its 30th year of life outside of the organism from which it arose. In other words, it is potentially immortal. This is not a probability, but an irrefutable fact. In a few cases chickens have lived over 20 years, but the average lifetime of the barnyard fowl, if it can escape the axe, is not much over ten years. Hence, these cells derived from the chick embryonic heart muscle in 1912 have far outlived the chicken into which the embryo would have developed in the natural course of events.

If it had been feasible to keep, and nourish, every sub-culture that could have been derived from the original tiny fragment of heart, dividing each in turn *ad infinitum,* the mass of tissue would now be far larger than our whole solar system could contain. That, of course, sounds fantastic, yet it is mathematically demonstrable.

As the culture continually tends to form a more or less compact mass of tissue that doubles in size every 48 hours, each fragment must be subdivided, if its bulk is to



Courtesy Dr. Carrel. X 412

Living old strain fibroblasts

Lederle Laboratories photo

This technician is transferring tissue cultures and giving them fresh medium in which to grow. Test tubes at left contain culture medium. Carrel flasks, in which tissue is artificially grown, are at the right. Black clothing and black surroundings reduce reflection of light and improve the technician's level of visibility in performing this exacting work

be kept within practicable limits. Moreover, nutrition, respiration, and elimination of waste products are limited by the size and by the physical, physiochemical, and chemical conditions of the culture. For these services the cells depend upon the diffusion of substances through the semi-solid, jelly-like medium in which they are kept. Thus, if the culture were allowed to grow into compact masses, then those cells in the thickened portion would suffer from lack of proper nourishment, sufficient oxygen, and removal of waste products. Some cells would die, others would be poisoned, and total death of the culture might result.

Actually, therefore, the average individual piece of tissue that is transferred to fresh medium is not larger than the head of a pin.

When the strain was started in 1912, it was necessary to transfer the tiny fragments every 48 hours, but later the method was modified and now transfer to new medium is less frequent.

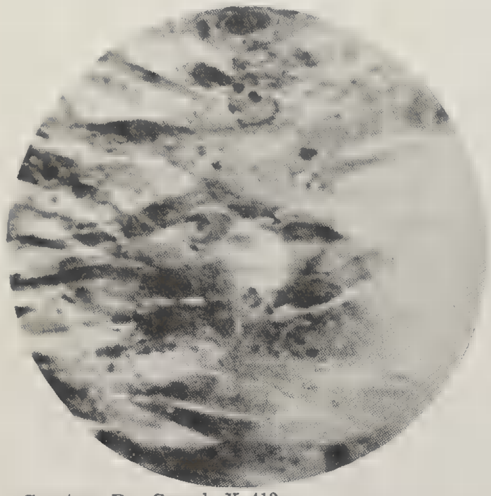
The strain is ordinarily kept in small, flat, tightly-stoppered glass containers—Carrel flasks. The Carrel flask,developed for this type of cell culture, is made of Pyrex glass an inch and a half in diameter, about half an inch high, with an oblique neck. The amounts of nutrient medium and air in a flask are large in proportion to the total mass of tissue, so that several fragments (from two to four) can be kept in one flask, and transfer to a fresh medium need be made only every seven or eight days. The life processes—metabolism—of the tissue produce no dangerous variations in the condition of the medium during the length of its stay in a flask. Any surplus tissue is discarded at the time of transfer.

IN ALL the procedures involved in the cultivation of these cells, rigid aseptic precautions must be taken at all times; that is, the cultures must be kept completely free from bacterial contamination. The medium best suited to maintain the optimum multiplication of these cells is composed of chicken plasma, chick embryonic juice, and Tyrode's solution, mixed in certain proportions. Each of these constituents of the medium is especially prepared for the purpose.

Plasma, the clear fluid part of blood, is obtained by bleeding an anesthetized chicken from a suitable artery under aseptic conditions and separating the cell elements—corpuscles—in a centrifugal machine. The clear fluid that constitutes the plasma is drawn off and preserved in a refrigerator.

Chicken plasma obtained under proper conditions will remain fluid for weeks, and thus can be stored for use at any time.

The embryonic juice is prepared by finely mincing the tissue of unhatched chick embryos and separating the fluid part. This juice also can be stored in the refrigerator for use. The embryonic juice contains most of the essential nutritive as well as growth-promoting substances required by the cells for their continuous multiplication. Some essentials, of course, are furnished by the constituents of the plasma.



Courtesy Dr. Carrel. X 412

Stained old strain fibroblasts

Tyrode's solution is a solution of several salts and glucose. It acts as a diluent for the plasma and tissue juice, and supplies certain metals essential to cell growth.

When the medium is needed, plasma is combined with the tissue juice and salt solution. Soon after these constituents are mixed, coagulation — clotting — occurs. Hence, it is necessary to introduce the medium into the culture flask and, while still fluid, submerge the tissue fragments in it. Then, when the whole is left undisturbed, a soft, uniform clot quickly forms. This is firm enough to hold the tissue fragments in place and, at the same time, to furnish an invisible, fibrinous network in which the cells can multiply, and through which the fluid part of the medium and oxygen (from the air contained in the flask) can diffuse to reach the cells.

During their stay in the flasks, the cultures are bathed at intervals by introducing a quantity of Tyrode's solution, leaving it for a time, and then withdrawing the fluid by gentle suction in order not to disturb the coagulum. After this washing to remove waste products, fresh, diluted embryonic juice is added to replenish the food supply. Enough air enters the flask during the manipulations to renew the oxygen supply.

Microscopic observations of the cultures can be made at any time at moderate magnifications. For high magnification (1000 diameters or more), fragments of the tissue can be transferred to specially constructed containers—microflasks—which have paper-thin glass walls. Also, cell behavior in these flasks can be permanently recorded by micro motion pictures.

In July, 1939, Dr. Alexis Carrel retired from the Scientific Staff of the Rockefeller Institute for Medical Research. His department, the Division of Experimental Surgery, was discontinued and his organization dispersed. The writer, who was associated with Dr. Carrel for over 27 years, brought the "old strain" to the Division of Virus Research at the Lederle Laboratories in Pearl River, New York. Here, in a well equipped, modern tissue-culture laboratory, the strain continues to live uninterruptedly. Two former technical assistants of Dr. Carrel, Mrs. E. Hull and Miss D. Olmstead, are responsible for the important work of maintaining the stock cultures.

No other laboratory in the world possesses this strain under cultivation. Through the years, Dr. Carrel gave cultures of it to various individuals in research laboratories here and abroad. There is no record of any of them having survived. Hence these laboratories have the unique distinction of being the sole custodians of Dr. Carrel's original, potentially immortal strain of cells.

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IN BIG DEMAND: In the entire nation there are less than 5000 physicists, and of these between one third and one quarter are already engaged in defense work.

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CRYSTALS

Structure Demonstrated

By Steel Balls

STEEL ball bearings are used by scientists to study the structure of all sorts of materials. Dr. Ralph P. Johnson, physicist in the General Electric Research Laboratory in Schenectady, is shown in one of our photographs, stacking up a model of a face-centered cubic crystal, such as is found in aluminum, silver, gold, calcium, copper, lead, and a number of other elements. Each steel ball represents one atom and is about 20,000,000 times the size of the real thing.

All crystalline substances have a specific geometrical arrangement of atoms which assists the physicist in identifying the material. The face-centered cubic type, as illustrated by the arrangement of the steel balls, is one in which each atom in a crystal is the center of a spherical cage formed by twelve surrounding atoms.

More than one material may have the same geometric arrangement of atoms. Once this type has been determined, usually by observing the pattern of diffraction of X-rays, the physicist distinguishes members of the group by the size of the atoms.

The arrangement of the steel balls shown in the picture is the densest that can be obtained. If a large number of similar balls were dropped at random into a pail, many would naturally fall into this arrangement. The group as a whole, though, would be more loosely packed than the balls arranged by Dr. Johnson.

In the background is shown the atomic arrangement of crystals of table salt, iron, and calcium carbonate. The square-block framework represents an iron crystal; the crystal of single-size spheres represents table salt; and the model containing spheres of two sizes represents a calcium carbonate crystal.

They represent atoms

Wheat Peeled For Better Bread

Process Developed by Mining Engineer Retains Grain Elements, Eliminates Fibrous Husks

H. T. RUTLEDGE

PEELING the wheat grain of its husk without cracking or injuring the kernel has been tried countless times, but each attempt to accomplish the feat in the last hundred years of milling in the United States has ended in failure. This peeling is desirable in order to produce flour from the wheat that retains all the desirable elements of the grain, without the splintery, indigestible husks, yet inventors and milling experts had reached a point where they were ready to declare that the task was impossible. They never dreamed that the job might be done by someone who did not have the remotest connection with milling or baking—but that is exactly what happened.

The wheat-peeling process was discovered in 1937 by Theodore Earle, of California, a mining engineer, who admittedly knew nothing of milling methods or milling machinery. Experimental tests continued and data on the process were checked for the next four years.

The Earle process was not originally aimed at wheat-peeling. Rather, it grew out of tests with seeds, made with mining machinery—flotation cells of the type used to separate precious metals from baser elements. After many experiments, Earle discovered that grain seeds classify themselves, when subjected to the flotation treatment, into "tails"—seeds that come to the top—and "concentrates"—grains that remain at the bottom of the flotation cells. Tails in wheat are found to be superior for milling purposes while concentrates are superior for planting because they yield the better crops.

IN A series of three tests of seeds so classified, conducted by the Kansas Wheat Improvement Association and the United States Department of Agriculture Bureau of Plant Industry at Hays, Kansas, the concentrates disclosed increased per acre yields of 22 percent, 7.1 percent, and 11 percent over those per acre yields of untreated wheat grain seeds. In the first two tests, the seed beds were cropped land; in the third test, the seed bed was fallow land. In all three tests, the same wheat grain variety was used.

Earle's chief interest, from the beginning of the experiments, was in the germination or fertility quality of seeds. He did not set out to find a way to peel wheat kernels of the fibrous, splintery, indigestible husk, or epidermis, that has been blamed for many gastric disturbances. Discovery of the peeling process occurred quite by accident.

In one test, wheat grains were mixed with water in a single flotation cell. The mixture was placed in agitation and then—the telephone rang. Earle answered the call but talked longer than he anticipated. When he returned to the cell, he found slivers of wheat husks floating on top of the water. He examined the grains and they were free of husks. That started the ball rolling. Dozens of follow-up tests took place in the ensuing months and finally the peeling process was perfected.

M. Lee Marshall, President of the Continental Baking Company, became interested in the achievement because one feature of the process was of particular importance: it removed the husk without cracking the wheat kernel. That meant that all the vitamin, mineral, and protein content of the wheat grain was kept intact. It meant, too, that these deposits would be ground into flour just as nature had stored them in the wheat kernel.

HERE was big news to a baking executive who had been looking forward to the day when he might market a bread that contained the wheat vitamins, but not the scratchy husks which give whole wheat bread its bitter taste.

Preparation of the wheat for actual grinding under the Earle process combines many of the steps employed in ordinary modern milling. The flotation method unites with these steps to establish a smooth-running process that produces flour from which is baked *Staff,* a new, natural wheat bread.

The business of receiving, binning, and rough cleaning wheat under the Earle process is like that used by all good millers. Ten cells constitute the peeling machinery.

Mr. Earle combing the slurry from an experimental flotation cell

These are rubber-lined tanks, each equipped with a rubber-covered impeller. The grain is mixed with water in such proportions as to form a slurry that can be agitated by the cell impellers. The ten cells are linked at the bases by connecting pipes.

The slurry of wheat and water enters the first cell and undergoes agitation by an impeller. Then an edible re-agent is added to the slurry to form a froth which collects the feathery husks as they break away from the kernels. The slurry moves rapidly from cell to cell, the wheat husks, which millers call "bee-wings," amassing on top, the wheat kernels dropping to the bottom. The froth is skimmed from the tops of the cells as it thickens.

Passage of the mixture from cell to cell occupies about nine minutes and the cleaned and peeled wheat leaves cell number ten to go to a vibrating screen that shakes much of the water from the kernel surfaces. The peeled grains then move into a whizzer, a continuous type of centrifuge, where more water is removed. From the whizzer, the kernels go to a dryer, through which flows a swift current of warm air. This dryer is a steel tube five feet in diameter and 30 feet long. It is fitted with a central flue and six concentric flues. Here the grains remain for about 12 minutes, moving at high speed and tumbling finally into the aspirator which takes out any specks of husks lodged in the kernel creases.

Still feeling moist to the touch, the grains flow to tempering tanks to remain several hours. When they emerge, they are externally dry. All moisture has been absorbed.

Now ready for grinding, the cleaned, peeled, dry wheat grains go to a battery of pulverizers of hammer-mill design and become flour containing the nutritive elements of the bran coats of the kernel, the vitamins (vitamin B_1, vitamin B_2, nicotinic acid), and the minerals and proteins of the berry, but free of the woody, outer coating.

The bread made from this flour contains 444 to 566 International Units of vitamin B_1 to the pound loaf, 1.02 milligrams of vitamin B_2 (riboflavin), and 12.7 milligrams of nicotinic acid. The methods used in these determinations were: (1) thiamin—biological, thiocrome, and fermentation: (2) riboflavin—microbiological; (3) nicotinic acid—colorimetric.

A typical freshly baked loaf of the bread reveals itself as follows in analysis:

Moisture	37.40%
Total Solids	62.60%
	100.00%

Composition of Solids	
Protein	15.92%
Ash (less salt)	2.13
Salt (NaCl)	2.17
Crude Fiber	1.71
Crude Fat	6.31
Carbohydrates	71.76
	100.00%

A comparison of white bread, ordinary whole wheat bread, and the new peeled-wheat bread discloses that *Staff* contains 2.13 percent minerals as against 1.14 percent for whole wheat and 1.03 percent for white bread.

Dr. John R. Murlin, food authority, University of Rochester, New York, recently told the National Nutrition Conference for Defense that the only way to get all the nutritive elements of the wheat grain into bread is "by producing whole-wheat flour and making whole-wheat bread." He explained that his own experiments with a natural wheat bread disclosed the following story:

"The average per-capita consumption of wheat is four bushels, or 240 pounds. Deprived of its roughest constituent, 2 percent only, by weight, ground without sifting or bolting whatever, the amount will make 355 pounds of bread as compared with 221 pounds on a rich formula from 75 percent extraction of the grain.

"The 355 pounds of whole wheat, according to digestibility figures in a recent experiment in our own laboratory, on ten men, would yield 356,000 and some odd calories; compared with a white bread eaten by the same men, 240,000 and some odd calories, a saving of 116,000 calories, or enough to support the average man on our diet squad for 36 days. In other words, eating whole wheat bread would save over a year's supply of energy for yourself in the course of a year."

Thus, through the happenstance of a lengthy telephone call, a new type of bread that appears to hold promise of economy plus added nutrition has been made available. These factors, and the seed classifications made possible by the original flotation experiments, may mean much to the average bread consumer and to the farmer.

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Desert Alphabet

Strange Letters of Stone are Found in the Sand Wastes of South-western Arizona

JOSEPH C. COYLE

Hidden here and there in the mosaic of Yuma mesa, and buried in its topsoil, I find the letters of the alphabet. Some of them are scarce, but many letters are more or less plentiful and are remarkably perfect in shape. With the collection I have, I build many words, sentences, paragraphs.

One day an army plane roared just above my head. Involuntarily, I ducked. When I straightened up I held a perfect capital A in my hand. There were already a Y and a couple of Ls in my rock pile. I could now spell "Ally" with stone letters.

These stones range in color from light gray to nearly black, and most of them are so hard that they ring like cast iron when struck together. Some are shapeless and porous, but there are quantities of them, from the size of a straw to three inches in diameter, which closely resemble, in contour, fragments of petrified native wood. Nearly all are without a semblance of grain, however. The greater part are fairly straight and under 12 inches long, though I found one an inch in diameter and 64 inches long.

Cloudy days, though rare at Yuma, are best for rock hunting, since the sun's glare on the light-colored desert is then eliminated.

Second best is early morning or late afternoon, when shadows grow long and every pebble in the desert mosaic stands out against the drab background of gray sand.

My stone vocabulary grew by leaps and bounds, but it still centered around words requiring Ls, Ts, Ys, and so on. One day I parked my automobile and stepped out. There lay a perfect Q. I could now spell "quit," "quill." The letter O eluded me for a long time, but I now have several—some strikingly perfect. Although I wanted to spell out my name with the stone letters, the only Cs I found at first were imperfect, and E apparently was non-existent. Then one day I spied a very good capital E which a kangaroo rat had kicked out of his tunnel.

Many of the thick patches of specimens resemble closely in contour those of clumps of growing mesquite brush nearby. I was amazed to find a round stone about an inch in diameter and three feet long, with a groove cut by termites along one side; also logs, one of which is 30 inches in diameter and 20 feet long, outlined in porous stone and closely resembling cottonwood in shape. Stumps are outlined in the same porous rock, with stone roots radiating from them. Underground, as well as on the surface, are long stone roots.

A well-known geologist to whom I submitted the evidence stated that the specimens, when tested with acid, proved to be sand grains cemented by lime. Also that, judging from the photographs and the method of occurrence of the specimens, these undoubtedly were once plant roots and stems which,

Formerly a five-foot root

in decaying, left hollow spaces in the earth. Sand then filtered into the spaces and lime was added through the agency of percolating waters containing this mineral in solution. As the plant root fragments would have been branched in many cases, and later broken, the accidental resemblance of a few of the specimens to letters is expectable.

It is my own further hypothesis that the shape of many of these letters, as well as the other strange loops and crooks, has resulted from termites plastering the roots and stems of native wood and plants with their familiar tubes of sand, which then became consolidated into stone by the infiltration of water impregnated with lime, as just explained. The layers and folds of sand on the exterior of some specimens cannot be distinguished from fresh termite work, when the two are placed side by side. More than once I have picked up what I thought was a nice specimen, only to have the outside fall away, revealing a stick of wood which had been only *recently* plastered by the tiny insects. These specimens of termite work are often partially or wholly hollow, where the wood, covered with sand, rotted away before hardening took place. Crossed, branched, and crooked sections of these specimens later broke into sections resembling in some cases letters of the alphabet and various other things.

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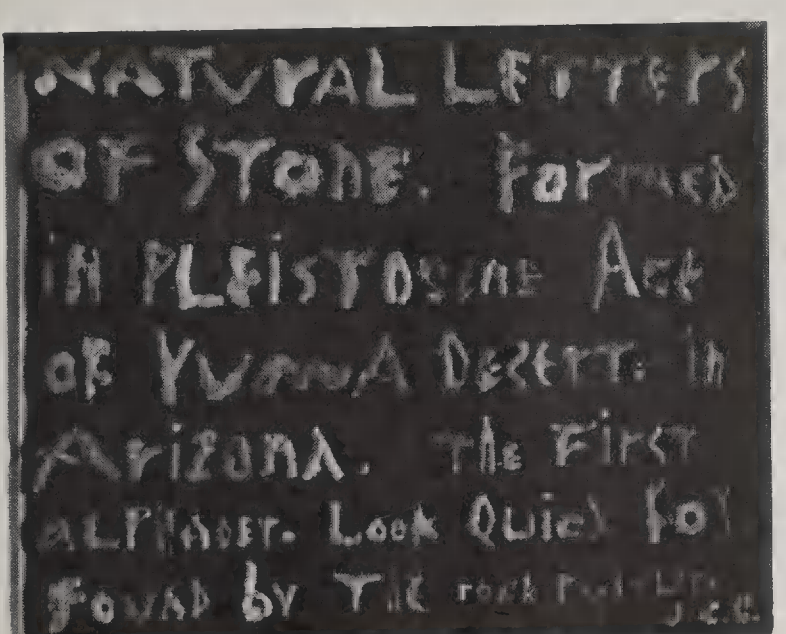
TROPOSPHERE

Studies Carried Out Near Sea-Level

Coldest spot in the United States is not Havre, Montana, but in semi-tropical Santa Monica, in Southern California, where at one certain spot the average August temperature last summer was around *minus* 40 degrees, Fahrenheit, and frequently dropped to 104 degrees below zero! These temperatures were recorded in a scientific ice box located at the Douglas Aircraft factory where experiments for bombers operating in the frigid troposphere can be carried out at the more convenient ground level.

Function of the "cold room," say Douglas engineers, is to simulate the conditions and effects of extreme low temperatures on the various components of high-flying aircraft. Since, at 35,000 feet, the



Found by the "rock russler," near Yuma

Further specimens of the same kind

troposphere has a near-constant temperature of 67 degrees below zero, the men, motors, metals, alloys, plastics, and other materials used at such heights must be thoroughly pre-tested.

The trick is done with a combination of solid CO_2—dry ice—and methyl alcohol. Agitated together and pump-circulated through a heat-exchange unit, this mixture will reduce the temperature in the cold room from plus 80 degrees to minus 104 in two hours. This bit of Siberia in Southern California is contained in a space some 14 by 16 by 8 feet. The room is insulated with 12 inches of fire- and corrosion-proof spun glass.

"Our test program includes a study under polar conditions of fuel, oil, and hydraulic systems, controls, structural parts, insulation, heating, windshield de-icing devices, bearings, lubrication, tolerances, metal fatigue, and countless other subjects," explains the engineering department.

Despite extremely low temperatures, men are able to work in the room without too great discomfort. They wear sheepskin garments and wrap themselves into wool-lined leather suits surmounted by helmets equipped with earphones and a telephone mouth-piece. The helmet, greatly resembling a diving bell, is made of spun aluminum welded to padded shoulder pieces of the same material. It has a fixed vizor of laminated Plexiglas separated by air chambers and hermetically sealed after all moisture has been removed. This effectively prevents fogging. It is lined inside with orthopedic felt and soft chamois skin. Neither suit nor helmet is electrically heated.

Since a principal danger to workmen in the cold room is the possibility of pneumonia, the suits are valved so the wearer breathes air warmed by his own body, the large helmet providing ample storage space. The intake is near the floor; the exhaust is located in the helmet dome.

ANTI-FREEZE

Conserved With Cooling-System Sealer

CONSERVATION of automobile anti-freeze fluids, urged for this winter because of defense needs, gains an ally in a newly developed liquid cooling-system sealer announced by Du Pont.

Leakage and the subsequent

over-heating account for thousands of dollars worth of anti-freeze lost annually, radiator specialists point out. The new cooling-system sealer is an inexpensive "ounce of prevention," against such losses. It is said to be harmless to rubber, aluminum, and other metal engine parts, and to flow with water. It not only stops existing leaks without clogging, but prevents new leaks forming in the system. Before the sealer is used, the cooling system should be cleaned to rid it of rust and scale.

RADIUM DETECTOR

Protects Those Working With Radium Compounds

AN INSTRUMENT which sounds a warning signal and flashes a red light when the quantity of radium or radio-active materials in the vicinity is too great for workers' safety has been designed by the Geophysical Instrument Company. The instrument, which employs a Geiger-Muller counter tube and an auxiliary circuit including standard vacuum tubes, also indicates the concentration of radio-active materials on a dial. Furthermore, it is possible, with this instrument, to check the strength of radium compounds in order to determine whether or not any such material has been lost.

ICICLES

Movies Use Cellophane And Waterglass

CHEMICAL icicles are used on many of Hollywood's movie sets. The icicles are made of cellophane and waterglass — the substance used to preserve eggs. After being shaped they are dipped in alcohol, which solidifies them, and then in paraffin. The latter forms a coating which melts under the heat of the spotlights, giving a realistic effect.

PANELS

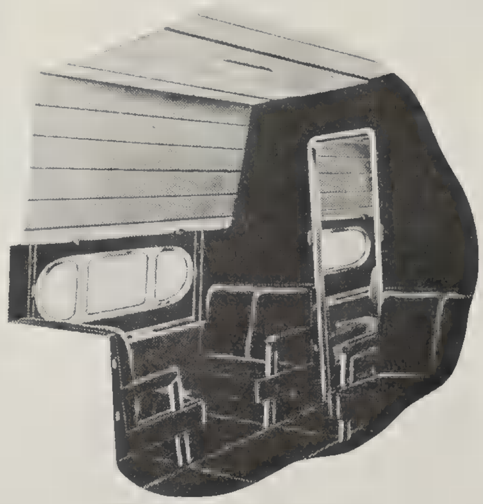
Of Light Weight For Transport Use

A MATERIAL which is establishing itself as being of particular interest to designers in the transportation field is Fybr-Tech, one type of which is being used as an interior lining for the huge flying boats which Vought-Sikorsky is building for the transatlantic service of American Export Airlines, Inc. The panels developed for this purpose weigh only one-fifth of a pound per square foot as compared with the average wall paneling weighing one to three pounds per square foot. This type of Fybr-Tech developed has a fiber face for strength, a balsa core for lightness, and a walnut face for beauty. This American walnut paneling is the key note of the decoration of the entire passenger accommodations in the new transatlantic flying boats.

This was, in a sense, an extreme and unusual form of Fybr-Tech; however, the principles involved in the material's construction are flexible, various factors being introduced to suit whatever application it is intended for. For surface transport use, a more orthodox construction of Fybr-Tech is used consisting of two faces of fiber with a birch or basswood core. With this a great increase in strength is gained with a certain sacrifice in weight, but both are present in sufficient proportions to make this form an efficient substitute for aluminum and other metal sheet in certain applications.

Greyhound buses alone, for example, have used over a quarter of a million feet for this purpose, while another manufacturer of buses will use large quantities of the material in their new models.

Among the advantages of this material for transport use is the fact that it is extremely easy to



Flying boat interior

work; it may be cut, drilled, die-punched, and bent to a radius of as little as one-half inch. It is resilient and will not dent easily; it has a tough, hard surface which will take a fine paint finish. It can be waterproofed, and used in conjunction with metal for unusual strength, asbestos for fire-resistant qualities, hollow-core construction for extra lightness, and with a veneer face for decorative trim.

VENTILATING

System Speeds Up

Tunnel Boring

SIX feet per day have been added to the push in the east portal of the 13-mile-long Continental Divide tunnel, being driven by the S. S. Magoffin Company at Estes Park, Colorado, since the recent installation of what is believed to be the most efficient and effective method of tunnel ventilation ever devised.

The ventilating system consists of heavy-duty blowers powered by General Electric 2200-volt, 100-horsepower motors, connected to the blowers by means of V belts. As the work progresses, the blowers are being installed every 9000 feet along the tunnel.

The installation of this ventilating system has cut twenty minutes from the time needed for each drilling cycle. So effective is the system that the men working in the heading can now return to their posts immediately after shots are fired, instead of waiting for the smoke of the explosion to clear.

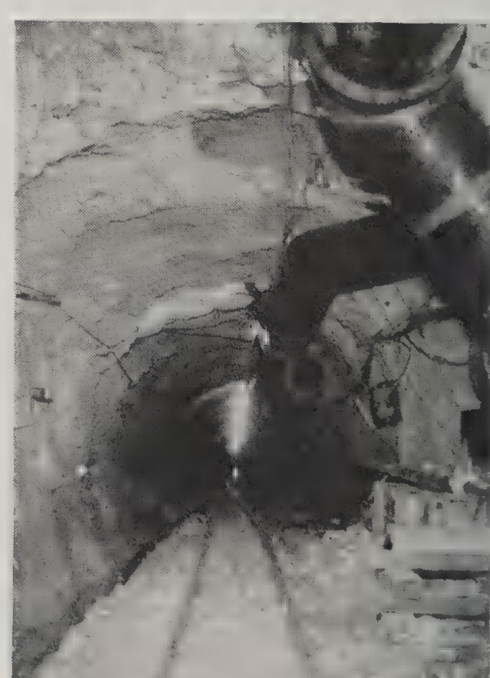
In addition to removing smoke from the bore, the ventilating system can be regulated to overcome the fog usually prevalent in a tunnel because of the difference in the temperature of the air at the portal of the tunnel and at the heading.

After holes have been drilled by the crew in preparation for blasting, the fans are shut down while powder is placed in the holes. The charge is then fired electrically. Immediately after the shot is fired, the operator in the compressor house at the portal of the tunnel—from where the blowers are controlled — is notified by telephone and the fans are started to exhaust the bad air from the tunnel.

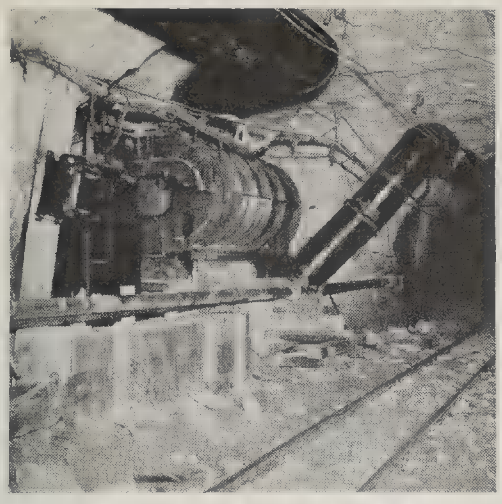
Twenty seconds after the blower in the heading of the tunnel starts, the next blower starts, and so on down the tunnel. This allows sufficient time for the air to reach each blower, thereby eliminating the possibility of a vacuum being created in the duct with a resulting inrush of air which might damage the blower or duct.

The fans exhaust for approximately 20 minutes, sucking all the powder smoke from the heading, and are then reversed to blow fresh air into the tunnel. After the "reverse" push-button is pressed, the motor in the portal of the tunnel delays one minute and then starts up in the opposite direction. This allows sufficient time for the motor to come to a rest before changing direction; plugging is thus prevented.

Twenty seconds later, the second blower picks up; the remaining motors start at 20-second intervals. The fans blow fresh air into the tunnel for about 30 minutes



Clear air, 9000 feet in



One of a series of blowers

and are then again reversed. Exhausting is continued until the heading crew is again ready to shoot, when the fans are shut off and the procedure repeated. This system requires only one pipe to supply fresh air and to exhaust bad air, and is much more economical than a double blower system.

Blowing and exhausting are timed to conform with outside temperature, to avoid fog collection in the tunnel. In this way, the heading of the tunnel as well as its complete length is always free from smoke and fog.

When completed, the fifty-million-dollar Continental Divide Tunnel will connect Estes Park and Grand Lake, Colorado, to bring water from the western slope of the Continental Divide to the eastern side, where it will be used for irrigation. In addition, immense quantities of power will be developed by the installation of turbo-generator units at strategic points. The project is under the direction of the United States Bureau of Reclamation.

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RAILROADS: Rails in present-day use on American railroads range in weight from 50 to 150 pounds per yard.

• • •

PUTTY

Remains Plastic, With Hard Skin

A NEW putty for glazing, sealing, and caulking that remains soft and pliable on the inside yet hardens to a protective skin on the outside has been made available by the Tamms Silica Company. It is claimed that the material will expand and contract with temperature changes and will not crack, crumble or fall off.

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

SOLDERING

Stand Holds Iron And Magnifier

RAPID soldering operations on small parts can be carried on efficiently with a new soldering-iron stand produced by the Photobell Corporation and illustrated in one of our photographs. The soldering iron is held in an adjustable clamp, the 30-inch pipe acting as a chimney to carry off fumes. The hood is for the protection of the workmen and is provided with a magnifying glass of two, four, or six power or with ¼ inch plate glass, as desired. Under the hood are two lamps which illuminate the work.

Fumes are carried off

In use the operator holds the work against the tip of the iron with one hand while solder is applied with the other, progress being watched through the lens.

INSULATION

Panels Can be Nailed To Ceilings, Walls

ACOUSTIC material in 12 by 12 inch or 12 by 24 inch plates is now available for application by nailing to flat surfaces. Produced in three standard thicknesses, the new material, known as Cushiontone, presents a smooth surface that can be cleaned with a vacuum machine or with ordinary wallpaper cleaner when it becomes soiled. It is claimed that it can be painted without loss of acoustical properties and that its characteristics include glare-free light reflection, heat insulation, moisture resistance, and light weight.

MARKER

Hand Operated Press For Nameplates, Badges, Parts

NAMEPLATES, tool checks, badges, metal or fiber tags, small production parts, and so on can be rapidly and economically marked with a new hand-operated marking tool recently placed on the market by the Acromark Corporation. Guide pins and holes in the table of this press-type machine are provided to locate work pieces accurately. A rack and pinion arrangement provide a leverage of 50 to 1 between handle and work.

POWDER METALLURGY

Reduces Machining Time, Releases Other Tools

THE use of "powder metallurgy" to manufacture many metal parts ordinarily made by casting and machining, forging, stamping, and so on, is one important way in which industry can save machining time and release valuable machine tools for other work, according to an article by Fred P. Peters, in a symposium on "faster production" published in *"Metals and Alloys."*

"This production method—the molding of parts to finished dimensions by pressing metal powders in dies and then heat treating—has only recently risen to prominence as another (and often faster or better) way of making certain metal parts," he says.

"Powder metallurgy presses are available that can produce small parts at rates up to 500 per minute, although production rates are normally between 25 and 150 per

minute. In one plant 10 million flanged bushings a year are being produced by powder metallurgy at costs that compare with those for similar pieces made from flat strip stock."

Nevertheless, Mr. Peters warns that powder metallurgy is no panacea and has numerous limitations. "The fastest metal-part production is probably obtainable by die casting, the closest tolerances through screw-machining.

"Powder metallurgy involves the least waste of material, but its tool costs are likely to be among the highest. A process like cold-heading and forming may provide a better all 'round combination of low tool cost, high production rate, low material-cost, and design flexibility."

HAND CREAM

Invisible "Gloves" Protect and Heal

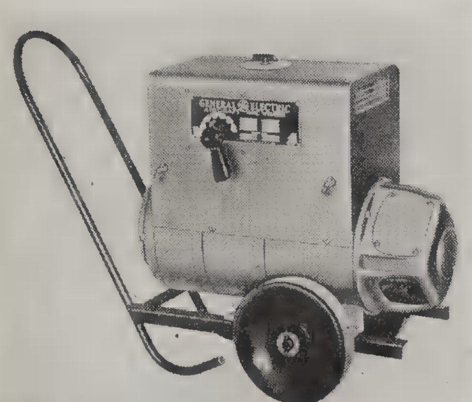
A NEW water-soluble hand cream that is applied to the skin before starting work guards the hands of workmen from grease, paint, ink, and other materials which are ordinarily difficult to remove. Known as Mitts, this cream washes off easily with soap and water, taking all dirt with it.

According to the manufacturers, one of the ingredients of this cream exerts a therapeutic action, helping to heal cuts and sores during the time the cream is in contact with the skin.

ARC WELDER

For Use on Thin-Gage Metal

FOR use in fabricating bright-surfaced, thin-gage metals, such as aircraft tubing (SAE-4130) which has a wall thickness of 35 mils, a new 150-ampere direct-current arc welder, the Strikeasy, has been



Portable welding current supply

announced by the General Electric Company. The design and characteristics of the new welder have been developed to help operators produce strong, uniform joints quickly and easily without spoilage.

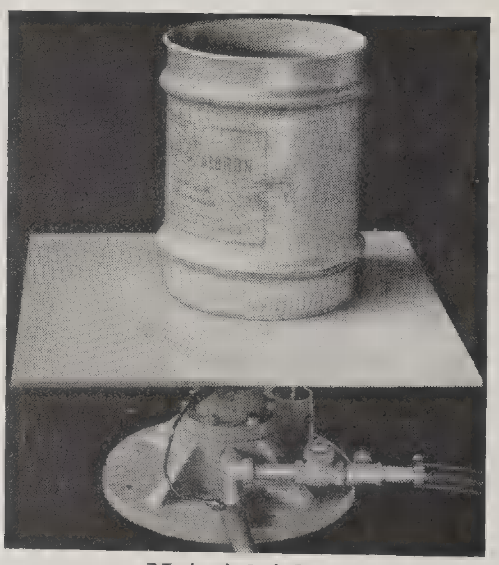
Chief among the features of the Strikeasy arc welder is its "pep" or extra high instantaneous recovery of voltage (40 to 60 volts) which helps the operator to strike the arc with ease under the difficulties presented by thin metals having a bright, polished surface. The wide welding range permits the use of shielded-arc electrodes as large as 3/16 of an inch in diameter and as small as 3/64 of an inch.

As a further aid to the operator in producing welds of uniform strength, the welder may be used with a remote-control device for reducing the current when the operator wants to fill a weld crater or when a reduction of heat is needed to avoid burn-through.

PACKING

Compacting Device For Settling Bulk Material

OPERATED by water pressure at approximately 50 pounds per square inch, a device is now available for settling light, powdered material in bulk containers. Materials such as soap chips, aluminum powder, and so on require this settling and compacting action in order to conserve space in containers.



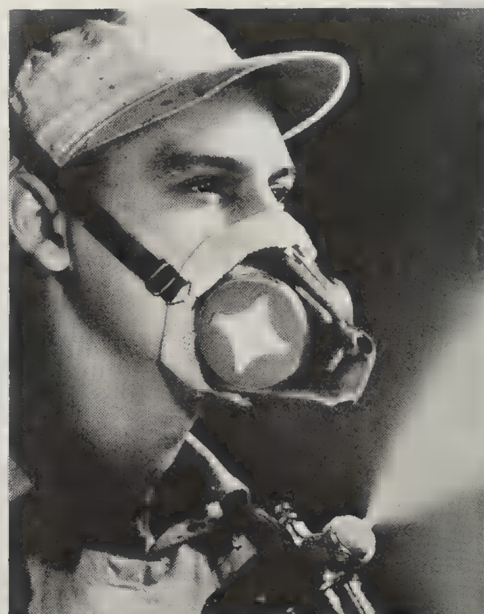
Material jolter

This new device, produced by the Syntron Company, is so arranged that the frequency and amount of lift can be readily controlled. The container of material is placed on the platform and a valve is operated. A cylinder then lifts the plate and drops it sharply about once a second. The equipment is available in a range of sizes and can be provided with a motor-driven pump to operate a closed hydraulic circuit.

MASKS

For Workmen, Use Plastic Pieces

PLASTICS are now being used in the construction of masks through which workmen may breathe without inhaling irritants suspended in the atmosphere. Made of shatterproof tenite, a plastic piece on each side of the respirator holds a felt filter which cleanses the air. It is lighter in weight and better in appearance than the aluminum part formerly used, according to the manufacturer.



Light-weight plastic side pieces are used in the respirator being worn by this spray-gun operator

The mask can be used in mines, breakers, granaries, and other places where dust threatens the health of workers. Painters using spray guns may also wear the device to protect themselves against fine particles of suspended paint. Air exhaled through the mask does not pass back through the tenite-held filter but it released by a valve in front of the respirator. The valve automatically closes when the wearer inhales.

The replacement of aluminum by tenite has lowered both labor and materials costs. The tenite parts come from the mold ready for assembly. They are molded by a process which turns out finished articles at the fastest speeds ever attained with plastics.

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

CAA FOR DEFENSE is a 16-page pamphlet on the work of the Civil Aeronautics Administration in civilian pilot training, airports, and airways, all aiming toward national defense and future peacetime safety and efficiency. Illustrated with photographs and charts. *Department of Commerce, Civil Aeronautics Administration, Washington, D. C.—Gratis.*

MINERALS YEARBOOK is a 1459-page authoritative reference work covering the whole broad field of minerals. Production, stocks, distribution, and consumption of metals, nonmetals, fuels, and mineral products are covered in a comprehensive manner with a large array of data. *Superintendent of Documents, Washington, D. C.—$2.00.*

ELASTIC STOP SELF-LOCKING NUTS is a four-page folder describing a relatively new type of lock nut and its various uses in a wide range of equipment where safe, vibration-proof fastenings are needed. *Elastic Stop Nut Corporation, 2330 Vauxhall Road, Union, New Jersey.—Gratis.*

THE CATERPILLAR CONDENSED CATALOG is a 36-page booklet, in two colors, devoted to track-type tractors, road machinery, Diesel engines, and so on. Each of the products is illustrated and brief specifications are given. Request Form 6425. *Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

THE OBSERVER'S HANDBOOK FOR 1942 contains data on the planets and other astronomical phenomena, month by month; also lists of double and multiple stars, variables, four star maps, an ephemeris of the Sun, and miscellaneous astronomical data to the extent of 80 very useful, practical pages. Most amateur astronomers obtain this booklet each year. *Royal Astronomical Society of Canada, 198 College Street, Toronto, Ontario, Canada.—25 cents.*

SURVEY OF ROOFING MATERIALS, by H. R. Snoke and L. J. Waldron, presents data on the weathering qualities and extent of use of various types of roofing materials on dwellings in the north-central states. 48 photographs illustrate the text. Request Report BMS75. *Superintendent of Documents, Washington, D. C.—15 cents.*

STRUCTURAL PLASTICS IN THE AVIATION INDUSTRY, by J. B. Johnson, is a copy of a paper, presented before the Society of the Plastics Industry, which surveys the various uses to which plastics are put in the construction of aircraft. Tables and drawings cover mechanical properties of plastics, tensile properties under varying temperatures, shear tests, and so on. *Society of the Plastics Industry, 295 Madison Avenue, New York, New York.—$1.00.*

PRECISION INSTRUMENTS FOR THE EXACTING INSPECTION OF INTERNAL SURFACES is a 12-page catalog describing and illustrating a series of industrial telescopes which are now finding wide use because of the increasing importance of visual inspection of internal surfaces, recesses, and hidden contours which cannot ordinarily be seen. *American Cystoscope Makers, Inc., 1241 Lafayette Avenue, New York, New York.—Gratis.*

PHOTOGRAPHY AS A VOCATION, by Andrew B. Hecht and George J. Berkowitz, is a 48-page paper-covered booklet which tells how the serious minded and talented camera hobbyist can prepare himself for a career in photography. Various photographic occupations are analyzed in a simple yet comprehensive manner. *Science Research Associates, 1700 Prairie Avenue, Chicago, Illinois.—50 cents.*

THE STORY OF VITAMIN A ESTERS is a descriptive pamphlet covering the process of molecular distillation whereby it is possible to produce concentrated vitamin products of high stability from fish oils. *Distillation Products, Inc., 755 Ridge Road West, Rochester, New York.—Gratis.*

PERFORMANCE OF PRESSURE-TYPE OIL BURNERS, by M. P. Cleghorn and R. J. Helfinstine, is a 32-page report of tests conducted primarily to provide information of assistance in the intelligent selection and operation of oil burners. Included is a tabulation of relative heating costs with coal and with oil. Request Bulletin 151. *The Director, Iowa Engineering Experiment Station, Ames, Iowa.—Gratis.*

A GREAT TEAM is a four-page illustrated circular that describes a new radio transmitter and receiver specifically designed for use by private fliers. The units are light in weight yet high in power and performance. *Lear Avia, Inc., Dayton, Ohio.—Gratis.*

WALKER-TURNER MACHINE TOOLS is a 56-page catalog illustrating and describing a standard line of metal-working and wood-working machine tools of all types. *Walker-Turner Company, Inc., Plainfield, New Jersey.—Gratis.*

TOOLING TURRET LATHES FOR SMALL LOT PRODUCTION is a four-page folder describing the use of Kennametal steel-cutting tools for this particular purpose. Desirable economies are claimed. *McKenna Metals Company, 1000 Lloyd Avenue, Latrobe, Pennsylvania.—Gratis.*

Molded Plywood Planes

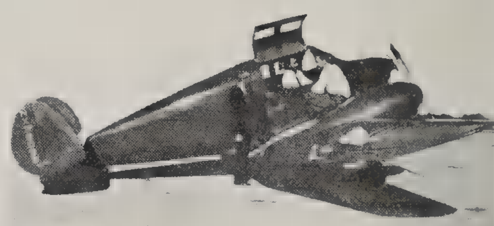
Plastics Plus Multi-Layered Veneer Used in Construction of New Two-Engined Ship

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

A SMALL, twin-engined plane, the Langley, has attracted favorable attention by its looks and performance. But, and this is more important, the new plane is built entirely of molded plastic-treated plywood by a process which helps the aluminum shortage and which lends itself to mass-production methods. Since the exact methods employed by the manufacturers of the Langley plane are not entirely available for publication, we shall quote verbatim from the maker's description, with the sole comment that the process is known to us as really effective:

"The molded plastic plywood parts of the Langley ship are multiple layers of veneer, formed over a mold and permanently bonded together into a completed structure by plastic compositions which react in their characteristic manner to heat and pressure. Each of the integral members—fuselage, wings, control surfaces, and cowling—are joined together without any mechanical fastenings such as nuts, bolts, or screws. In place of mechanical dies, the Langley parts are made on relatively simple wooden forms or molds, prefabricated strips of veneer being placed over each other upon the forms while dry." Parts as big as half a fuselage are thus produced in one hour or less, under applied pressure and temperature. Cowls and fire walls are molded with an integral asbestos lining.

Simplicity of construction, resistance to corrosion and to temperature effects are features of the plywood plane. Real possibilities appear. With two 65-horsepower Franklin engines, and a gross weight of 2300 pounds, top speed is 142 miles per hour, ceiling is 15,000 feet and take-off distance is only 200 feet. The Langley should



The plywood plane with hatch open and, *below*, ship in the air

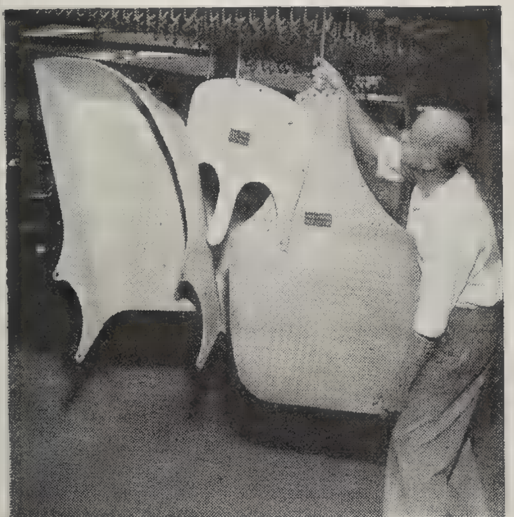
be a very useful training plane for pilots who are to fly fast twin-engined ships later.

Heading up the Langley Corporation is Caleb S. Bragg, an old war-time pilot. Working vice-presidents are Messrs. Draper and Jensen, with Smithline, a graduate of the Daniel Guggenheim School of Aeronautics of New York University, as the technical man of the group.

AIRPLANE ARMOR

Welding Produces Intricate Curved Sections

THERE are two types of armor plates, one known as face-hardened or carburized, in which carbon is added on one side of the plate for about a quarter of the thickness and the face becomes hard and capable of resisting even armor-piercing shells. The other type, called homogeneous armor plate, is uniformly hard throughout but is not so resistant to shell fire as the face-hardened type. Breeze Corporations inform us of an advance in the hitherto costly and tedious process of carburizing armor plate.



Three pieces of airplane armor

In the older process, the steel plates to be carburized are placed in metal boxes packed with carbon dust and wait for many hours before the heated steel can absorb the carbon on the chosen side. In the new Breeze process the plates are placed in large pots filled with liquid salts, heated electrically and accurately controlled. The result is closer control, more rapid and more uniform carburizing.

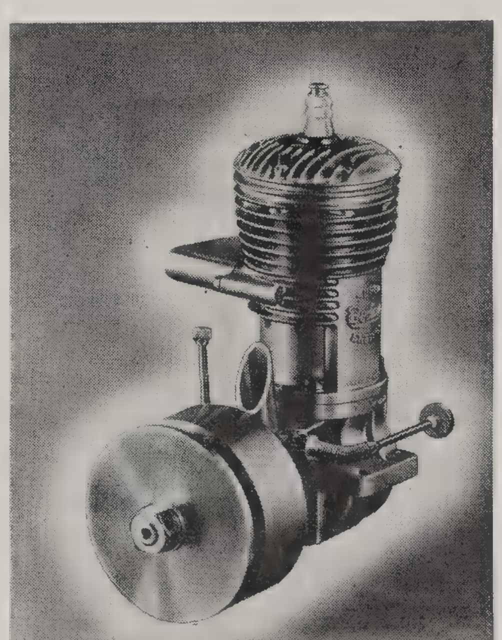
Another process which the ingenious Breeze engineers have developed is one of welding the finished armor plate together, making it possible to produce intricate curved sections such as, for example, the section of armor plate for shielding the pilot, is shown in one of our photographs. It looks like a small bathtub into which the pilot's seat is fitted. Other sections shown are gunner front shield in the center, and fighter pilot shield to the right.—*A. K.*

MIDGET ENGINE

For Gasoline-Powered Model Planes

THOUSANDS of American boys fly rubber-driven airplane models and do wonders with the primitive power plant of a few strands of rubber. Eventually they graduate to gas-driven models, and then the young engineers surpass themselves. Of course, even the most mechanical lad can hardly expect to build a perfect, tiny gasoline engine to power his model. That is where Aircraft Industries, Inc., help him out with a tiny "Super Cyclone Engine," which in its way is as fine as the giant Cyclones built by the Wright Aeronautical Corporation.

One of our photographs shows one of these fine little units, which operate splendidly without too much care by the boy engineers, and which are designed to stand a good deal of abuse since the models land themselves, at times, very roughly. The specifications are complete and thorough. Two-port, two-cycle, air-cooled. Fuel admission through rotary crank valve, Normal horsepower 1/4 to 1/5. Bore 15/16, stroke 15/16. Weight bare only 7¼ ounces. Propeller 13 inches diameter, revolving at between 6000 and 7000 revolutions per minute.—*A. K.*



7¼ ounces, 1/5 horsepower

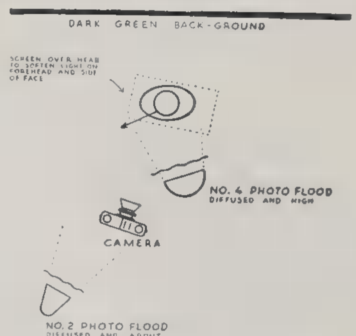
CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

The Professional On Portraiture

THE work of the professional portrait photographer is, in too many instances, so humdrum and lacking in imagination that when we have the opportunity of meeting one who still retains his amateur enthusiasm and a consciousness of fine technique, we never fail to listen. One such photographer is Maurice Carnes LaClaire,

Figure 1



whose exhibition of portraits made with the Contax recently attracted wide interest at the galleries of Carl Zeiss, Inc., in New York City.

We reproduce three examples from the show, together with lighting diagrams. Discussing Figure 1, Mr. LaClaire said that while the general rules for portrait lightings hold good for the average subject, it is sometimes advisable, and even necessary, to disregard accepted rules. Therefore, instead of using a broad lighting effect with this subject, he deliberately used a top front light which, he felt, brought out and emphasized the planes of the woman's face.

"This young lady has very small eyes," he continued. "Illuminated by the conventional 45-degree side light they appear very narrow and lack expression. By using the top light well forward, emphasizing all the planes of the face very strongly and by using the low point of view for the camera I have succeeded in giving this subject both dignity and expression. The subject has a mixture of large and small features which, taken from the normal viewpoint, would bring out none of that which is best pictorially, but these very features are *made* to dominate and carry the eye about in the picture area. Notice that the whole action of the head is carried out from the lines of the neck to the direction of the eyes."

The lighting arrangement is shown in the diagram. The No. 4 Photoflood is diffused with one thickness of tracing cloth placed near the camera and well above the subject. To soften the light on the forehead, a small screen was used. For illuminating the shadows, the No. 2 bulb was placed well back and close to the floor.

Figure 2 is one of the most difficult, yet among the most characteristic and agreeable shots in the baby photographer's repertoire. The problem lies in keeping the lighting general and soft, at the same time balancing the artificial light with the daylight illumination coming through the window.

"This picture was made in the nursery and was illuminated in such a way that the light, while ample, was not a hardship on the tiny eyes," Mr. LaClaire explains. "With a fast lens and the fast film available nowadays, it is possible to make excellent portraits with a very small volume of light. In this instance a No. 4 Photoflood was turned directly up so that the undiffused light struck the ceiling and filled the room with light. This gave an excellent and very soft gen-

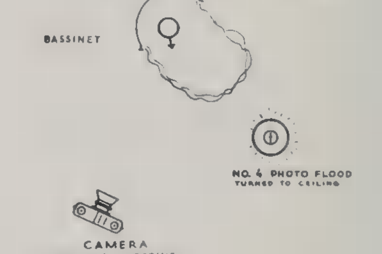


Figure 2

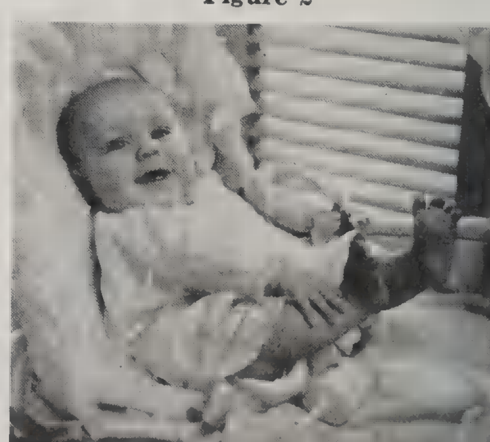
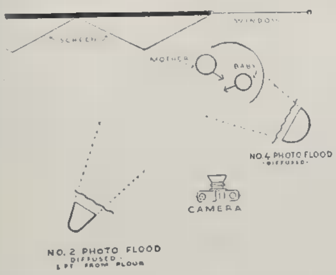


Figure 3



eral illumination. As you will note, the bassinet was placed close to the window and the accent light comes from the window, no other illumination being used."

An example of group portraits in the home is shown in Figure 3. The picture was made in a very small apartment. To prevent a black void in back of the subjects and to keep the tones of the picture harmonious, Mr. LaClaire used a light folding screen beside the window.

Mr. LaClaire suggests that should you have trouble having the mother hold the baby comfortably, you will find it helpful to crowd a small cushion or two between her elbow and the chair; this also helps support the weight of the child's head.

"Keep the light out of their eyes as much as possible," he advises baby photographers. "If they are lying down, have the light at such an angle that their eyelids shade their eyes, and by no means, when the baby is brought into the room, have the light turned on full. Reflect it against the opposite wall, gradually turning it so that the strength of it falls on the baby after his eyes have become accustomed to the more intense light.

"You will notice that while the window is in the picture, it is supplying none of the light that makes the picture. Had the light from the window been too strong, it would have outlined very disagreeably the baby's bald head and thrown too strong a light on the mother's face and far too much on the toys. And, speaking of the toys, I wish you to note that they are a number of shades lower in tone than the area surrounding the baby."

The lighting arrangement, as shown in the diagram, consists of a No. 4 Photoflood, diffused with one thickness of tracing cloth, in front and slightly to the right, and a No. 2 bulb in a clamp light fastened to the leg of a chair and some distance from the subjects.

Professional Aid

The Professional Photographers' Association of Connecticut, in line with a newly formed policy to "bury the hatchet" and get together with amateurs "in an all-out movement for the advancement of photography," recently voted to offer, through the camera clubs of the state, a loving cup to be known as the "Professional Photographers' Cup, 1942." Other aids are part of the general program, including availability of the association's various departments to the amateur clubs in the state.

Scholastic Awards

The Kalart Company announces its co-sponsorship, with *Scholastic Magazine*, of a nationwide competition among high-school students. This national magazine, the largest of its kind in this country, is used as a text in 8000 senior high schools. In connection with a division of photography, Scholastic awards have been made for 17 years. The 18th Annual Scholastic Awards, to be announced soon, will include a special Kalart Award "for the best pictures taken by high school students, using a synchronized flash."

New Reflector Material

Designed for purposes of home insulation, a new material called Metallation, now on the market, is incidentally a very fine reflector for photographic use. The material is a composition similar to foil and is mounted on a thin but fairly stiff paper, which permits rolling up. One side is glossy, the other less glossy, almost semi-matt, thereby offering a double-purpose reflector, providing either the directional, strong reflection of the one, or the more diffuse reflection of the other. Bending the reflector in various ways will afford a selection of reflection angles. The material need not be mounted on a stiff cardboard but may be used as is, fixing the shape as circumstances dictate. The material is 25 inches wide and, in the quantity needed, very inexpensive.

Props for Effect

Famous for his original ideas in portrait and fashion photography, George Platt Lynes is also notorious for collecting odds and ends of apparently nothing at all, for possible future use in out-of-the-ordinary portraiture. An example is the reproduction of a portrait he made of the ballet dancer,

Photo by George Platt Lynes

Tamara Toumanova

Tamara Toumanova. During a visit to Chinatown one day he noticed some Chinese painted kites on display, and purchased a few. These came in handy when he was arranging a shot of the dancer. One of the kites he pinned on the subject and a few others were pinned on a stretched white cloth behind her. The stretched cloth was then lighted from behind to give a luminous quality to the background.

Movie of Color Process

A 16mm motion picture film demonstrating, step by step, the processing of a color print by the Iso-Color Process, has been produced by the makers of the process, the Spectrum Products Co., Inc. This company offers to lend the film to camera clubs without charge. The film demonstrates how a color print can be obtained from a set of Kodachrome separation negatives in 40 minutes.

"Because there are only nine simple steps to the Iso-Color Process," says the announcement, "and because of its simplicity. . . it is possible for the first time to show the entire development of a color print in a film running only 15 minutes."

Guide Numbers

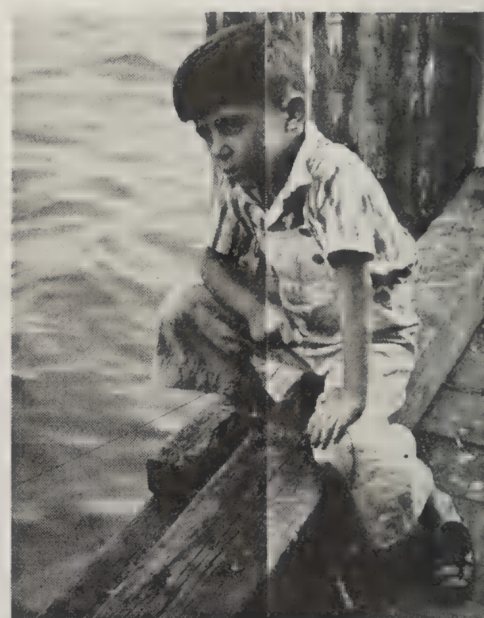
THE new system of exposure with Photoflash and Photoflood lamps, by which flash and flood bulbs of various sizes are assigned numbers for use as bases in determining the proper *f/* stop to use, is one of the greatest conveniences to come the amateur's way in a long while. The system is simplicity itself, but since there are some who seem a bit puzzled, let us review it briefly here.

Guide numbers are assigned to individual bulbs according to the speed of the film being used (Weston or other film rating) and the shutter speed to be employed. The distance in feet of the lamp from the subject is then divided into the guide number, the result furnishing the *f/* stop at which the diaphragm is to be set. Let us take a specific example. The Guide Number for a certain bulb at a given shutter speed is 160; the distance from lamp to subject is 10 feet. Divide 160 by 10—result 16, the *f/* stop to be used. Could anything be simpler?

The system is now being applied to flood bulbs as well, but manufacturers generally recommend that exposure meters be used where possible.

New Tone Treatment

A NEW corrective treatment for negatives, prints, film and glass positives, and so on, is introduced in Supertone Clarifier, a two-solution formula designed to improve the quality of photographic images. The formula includes, in addition to the Clarifier, the Supertone Fixing Solution, and works equally well whether local or general treatment is desired. A few seconds immersion in the Clarifier is generally sufficient to effect the characteristic action of the



Untreated and treated

treatment, that is, to remove a thin veil of metallic silver density from the image, thereby rendering it more brilliant. Softness may also be obtained, if desired. The typical action of the solution is demonstrated in the illustration, which shows a print after half of it was treated with the Clarifier.

Entry Forbidden

AS YOU can readily see, the figure in the left foreground is both a blessing and a curse so far as good composition is concerned in this particular print. It helps arrangement by lending weight to the left part of the picture, thereby materially aiding balance of the several elements. Unfortunately, however, because of the distinctness of the man's face and hands and the fact that he is staring directly at the camera, attention is diverted, though temporarily, from the main object, which is the man wheeling the truck into the light. Entry of the eye into the picture is

"Morning Sunlight"

therefore done hesitatingly because it is stopped by the prominence of the figure in the foreground. The thing to have done, of course, was to have waited until the man had turned his face profile. In addition, it would still be necessary in printing to do some dodging to cut the tone of the hands and face, as well as that of the packing box on which the man is seated.

Military Uses of Photography

Several of the most important uses of photography in the Army were recently outlined by Colonel M. E. Gillette, Commanding Officer, Signal Corps, Fort Monmouth, before the Westinghouse Photographic Lighting Conference in Bloomfield, New Jersey. These included:

As an aid in military operations. Pictures from the air are made during reconnaissance flights and are used to study military operations where maps are inadequate and where ground crews cannot go.

As an aid to military training. Instruction by means of motion pictures saves a great deal of time and is much more effective than any other method.

In engineering work. By means of pictures, both still and moving, the Army learns what happens to equipment during tests.

Supplying news pictures to newspapers, magazines and other publications.

For record or historical purposes.

• • •

WHAT'S NEW

In Photographic Equipment

King Slide File Boxes (100-slide capacity, $2.50; 200, $4.50): For storing 2-by-2-inch color slides. Two sizes, one holding 100 slides, the other 200 slides. Finished in imitation leather. French lapped rounded corners add strength.

Maskoid (2-oz. bottle, 85 cents; 4-oz., $1.55): New-type frisket for multiple toning and other uses. Called "the liquid mask"; of pre-vulcanized rubber composition (not rubber cement) dries quickly after application. Forms temporary protective film for local work in coloring, retouching, bleaching, and so on. May be applied with pen or brush, or sprayed on with airbrush. May be removed by stripping from surface. Thins with water; dyes and acids will not penetrate it.

Lewis Multiple Slide Viewer ($3.25): Loads up to 36 color slides at one time for continuous, uninterrupted viewing. Shifting of lever changes slides. High power plano-convex lens. Viewer fits over both eyes, excluding outside light except through transparency. One screw adjustment changes for either ready-mounts or glass slides. Made of wood and solid black fiber covered with black leatherette.

Lewis Bulk Film Loader ($2.20): For loading bulk 35mm film. Darkroom needed only to transfer film from original wrapping. Cartridges wound by daylight. Loads for any number of exposures and holds up to 100 feet of film. Made of solid black fiber, leatherette covered. Holds two extra cartridges. Winding directions gold-stamped on lid.

Amateur Press Photographer's Outfit: Flash-camera outfit including: Agfa Cadet-Flash camera; flash unit with reflector; eight Mazda Photoflash lamps; adapter for lamps; two No. 915 Eveready batteries; two rolls Agfa 8 (127) Superpan Press film. Camera has fixed-focus lens. Flash unit easily attached to or detached from camera. Shutter automatically synchronized with flash mechanism.

Signal (16-oz. bottle, 45 cents): Called the "indicating" shortstop. Colorless when fresh, turns rose-red when exhausted. Signal (undiluted) may be substituted for 28 percent acetic acid in same proportion as called for in regular photographic solution. Each pint bottle makes 20 one-pint baths.

Lyons Speed Graphic Case ($19.50): Designed for the 4-by-5 Speed Graphic, to accommodate the camera, 12 holders, complete flash outfit, and extension flash unit. Special compartment in top of case for storing flash bulbs. Case can be carried by means of shoulder strap with bulb compartment open. Made of plywood, covered with black leatherette. Nickel finished hardware. Case measures 17½ by 8¾ by 13½ inches. Weighs 8 pounds, 12 ounces.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

A Tyro Stocks a Rifle

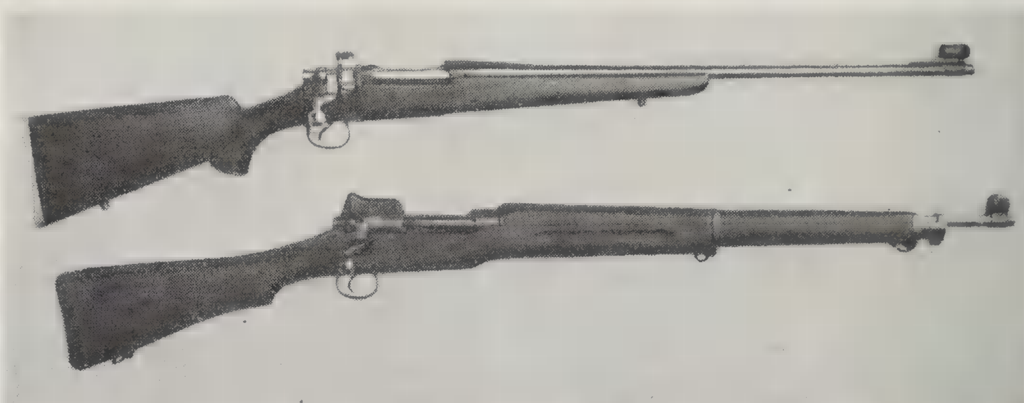
Harry A. Groesbeck, Jr.

A FEW years ago I picked up a copy of *The American Rifleman* and was intrigued with an article on the re-stocking of a .45-70 Springfield. I have been burning powder and fondling guns for more than 50 years; I have some skill with tools, for working both wood and metal, but will you believe me when I confess I had never even thought of combining my two pet avocations? When I consider my present day enthusiasm for amateur gunsmithing, it is hard for me to believe I am the same man who once gave away his entire gun collection, considered himself washed up.

The amateur gunsmithing job started simply enough, with a new front sight; then followed some polishing and refurbishing of a few old cap-and-ball hand-guns. Harold F. Kent, of Lawrence, Massachusetts, is the man who really upset my peaceful apple-cart. He sent me a 1917 Enfield and dared me to re-stock it. When the hardware arrived, it was a pretty sad-looking outfit. Someone had already started to butcher it and I suppose it aroused my sympathy, especially as Kent sent with it a most complete description of how to proceed on such a job. (Remodeling Military Rifles—How to Transform a Military Rifle Into a Modern Sporter. Technical Bulletin 104, National Rifle Association.—*Ed.*)

After reading this useful little article, I blew myself to Clyde Baker's book on gunsmithing, which I read from cover to cover before starting on my venture. Then I sailed in.

I should enjoy writing a most detailed account of every move I made in completing this job, but it would serve no good purpose. I came to the job as an absolute tyro in this particular field and I simply followed the books—as a good novice should. Did I say I followed the books? So I did, but I want to qualify that statement just a bit, because when I did *not* follow them, I sometimes found myself in hot water. It is about that punishment I feel I should write, lest others do as I did and then fail to have the good fortune that pulled me through.



Above: **Remodeled Enfield. Note front sight, fashioned from steel block; metal recessed buttplate.** *Below:* **A 1917 Enfield rifle, as originally issued**

The lads who have been doing this sort of work all their lives, both as amateurs and professionals, know what they are talking about. They have written guides to be followed by others, and they have planned these instructions in such a manner as to save their readers no end of trouble. Every time I got cocky and went off on some track of my own, I paid. How many times this happened is my secret, but my worst offense was impatience. Like all beginners, I yearned to see "how it would look."

When I shaped both the stock and the fore-end before thoroughly finishing the bedding-down of the action, I found I had nothing to hang on to while completing the work. I used more time finding a way to squirm out of that hole than the man who paints himself into a corner of his room. Anyhow, I finally finished the job, and despite my foolishness in some instances, the rifle came out well. The bedding-down is accurate; a full "blue" fit of wood to metal. The lines follow those prescribed by the authorities, with but slight deviations of my own. The finish turned out beautifully—and that baby groups the shots on the target to beat the band!

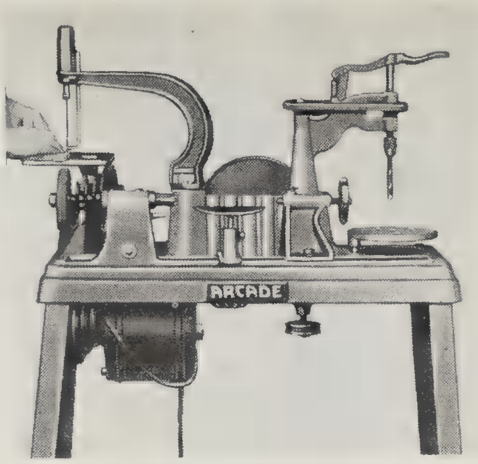
Frankly, while I am proud of the

job, I seek neither publicity nor praise for the accomplishment. Rather, I tell the story to encourage others to go and do likewise, and I have many good reasons for so doing.

First, let me pay my little tribute to the National Rifle Association for, among other things, starting me off right. Then, consider how much one can learn of the most intimate "innerds" of firearms, if one has to reduce them to their individual components in order to work on them. Also, there is the fun of doing it and the utilizing of some very worthwhile "junk" which, in these troubled times, may turn out to be priceless. Finally, there will be the knowledge gained, to be passed on, perhaps, to some youngster who is facing the most serious times of his young career. Who knows but that a tip from some "old guy" who dabbles with guns, and who knows not only what to do with them, but what *not* to do, may stand some boy in good stead in a moment when things are happening fast. — (We've visited Harry Groesbeck's workshop in the basement of his home, seen his tools and equipment, and some of the rest of his accomplishments. For those who like to work with wood and metal, but who have been fearful of entering the field of firearms tinkering, his is a most encouraging example, for his gunsmithing activities have been going on only three years. Nevertheless, he is turning out masterly work, and at present is engaged in re-stocking an old Krag that saw service in the Philippine Insurrection of 1899. The gun was captured by Aguinaldo's native troops, later recaptured by Major Philip Eastwick, of our Army, and one day soon, dressed as a sporting rifle, it will demonstrate its inherent accuracy, doubtless enhanced by the work of the amateur gunsmith.—*Ed.*)

Complete and Compact

For the sportsman who would make his own gun cabinet, gun racks, pistol range shooting box, and other items, and whose workshop space is limited, "The Craftmaster," by Arcade Manufacturing Company, solves the small shop problem neatly and efficiently. Equipped with jig saw, drill press, disk sander, grinder, and a lathe which, through accessories, may be extended, this compact unit is operated by a single ¼ H.P. electric motor on adjustable mounting plate which permits operation of any



"The Craftmaster"

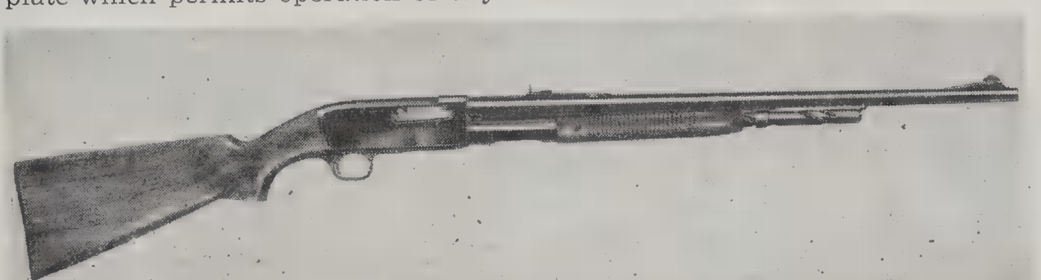
tool without interference from others by a simple change of the V-belt. Overall dimensions are: length, 29¾ inches; width, 20 inches; height, 44 inches. The cast iron base on which the five tools are mounted is 13 by 27 inches, and is 28¾ inches from the floor, supported by steel legs.

"Gamemaster" Gets New Sights

Back about 1910, Remington Arms Company brought out their original Model 14 slide- or pump-action rifle for big game hunters. It met with instantaneous acclaim for many sound reasons, but since then it has been re-designed and is now known as Model 141—"The Gamemaster." Still with slide-action, it is adapted to the .30, .32, and .35-caliber Remington cartridges, has 24-inch round barrel, pistol-grip stock, weighs about 7¾ pounds, has a five-cartridge capacity tubular magazine, and step adjustable rear sight with white bead front sight.

Never intended as a target rifle, it is, nevertheless, an extremely popular gun among the army of deer hunters because of its accuracy, ease of operation, and speed of fire, especially in wooded country. Another reason for this popularity is the similarity in general lines to the slide-action shotgun. Save for an annual week or two, many deer hunters are otherwise shotgun devotees, and the swing of "The Gamemaster," as it comes to the shoulder, is less foreign than would be either a bolt- or lever-action rifle.

Now comes the Marble Arms and Manufacturing Company with a flat-top sporting rear sight (No. 63H), sporting leaf sights (Nos. 69H, 70HH, 71HH), and an adjustable leaf sight (No. 95XH), all specially designed for the new Remington Model 141.



Remington's "Gamemaster"

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

FATIGUE OF WORKERS

By Committee on Work in Industry, National Research Council

NOTABLE report of a notable committee, concerning fatigue in relation to industrial production. Content: hearings; conclusions; heat and high altitude; industrial causes of illness; Western Electric researches; the interviewing method; self-expression and labor unions; extra-time allowances; study of organization. (165 pages, 6 by 9 inches, unillustrated.)—$2.60 postpaid.—*A. G. I.*

THE AMERICAN ANNUAL OF PHOTOGRAPHY 1942

Volume Fifty-Six

IT's here again—the cream of photographic endeavors for the past year, a series of articles on various aspects of photographic technique, the usual "Who's Who," the annual formulary, and all the rest of the features that have made this annual publication the standard in the field. (280 text pages, 44 ad. pages, 7½ by 10 inches, lavishly illustrated.)—$1.60 postpaid.—*A. P. P.*

THE THEORY OF ORGANIC CHEMISTRY

By Gerald E. K. Branch and Melvin Calvin

AN ADVANCED course, in which G. N. Lewis' ideas of atoms and bonds is incorporated with the classical structural theory, resulting in a structural theory whose fundamental concepts are valence electrons and atomic kernels. This electronic structural theory and its application to organic chemistry is the subject matter of this book, written by a professor and an instructor of chemistry at California University. (523 pages, 6 by 9 inches, 47 illustrations.)—$4.10 postpaid.—*A. G. I.*

RETURN TO THE RIVER

By Roderick L. Haig-Brown

THIS book, by the author of "The Western Angler," presents the life cycle of a female chinook salmon from the moment she was spawned in a Columbia River tributary; her instinctive migration to the Pacific ocean; her return, years later, to native waters for her own spawning; and her death. An amazingly encyclopedic description of the life, habitat, food habits, migration, and other data on the salmon. Although brimming with ichthyological information, the data are so delectably wrapped in a fascinating narrative as to be easily digested by all readers. (250 pages, 5½ by 8½ inches, 17 full-page drawings by Charles DeFeo.)—$3.10 postpaid.—*A. D. R., IV.*

AMERICAN COTTON HANDBOOK

By G. R. Merrill, A. R. Macormac and H. R. Mauersberger

ALL THE latest practical information on the historic, economic, social, and technical phases of the cotton growing, manufacturing, and processing industry in the United States is given here in simple, non-technical language. (1124 pages, 5½ by 7¾ inches, over 600 illustrations.)—$4.80 in United States, $6.00 in Canada, postpaid.—*A. P. P.*

TECHNICAL DRAFTING

By Charles H. Schumann

FROM elementary principles to advanced work in various aspects of engineering drawing, the text of this work covers the whole field in a thorough-going manner. Because of the method of presentation—the text is divided into a first part for the student and a second part for the professional—the book becomes at once a text book for study and a reference book for engineers and architects. (793 pages, 6½ by 9½ inches, thoroughly illustrated with drawings.)—$3.60 postpaid.—*A. P. P.*

EARTH, MOON AND STARS

By Fred L. Whipple

MEMBER of the Harvard College Observatory staff presents authentic known facts on the planets, how the system holds together, the discoveries of Neptune and Pluto, determining the masses of the Earth and other bodies, the Earth as an abode of life, the Moon's influence on the Earth, observing the Moon, nature of the Moon; also on Jupiter, Saturn,

—OUR BOOK CORNER—

Uranus, Neptune, Pluto, Mercury, and Venus, and on Mars; also on origin and evolution. This parallels textbook treatment but is more readable, though not at all superficial. Excellent illustrations. A long table gives the positions of five planets month by month up to 1970. (293 pages, 5¾ by 8½ inches, 140 illustrations.)—$2.60 postpaid.—*A. G. I.*

PRIMARY GROUND STUDY MANUAL

Official Civil Aeronautics Authority information on History of Aviation; Theory of Flight and Aircraft; Parachutes; Aircraft Power Plants; Aircraft Instruments; Airport Traffic Control Procedure and Phraseologies. Also contains Digest of the Civil Air Regulations for Student and Private Pilots, which incorporates Certification of Pilots; Registration; Identification and Certification of Aircraft; Pilot, Aircraft, and Engine Logbooks; Air Traffic Rules. (140 pages, 4¼ by 7¼ inches, illustrated.)—50 cents, postpaid.—*A. D. R., IV.*

FIRST RADIO BOOK FOR BOYS

By Alfred Morgan

Simple radio sets that any boy can build are described and illustrated in complete detail. According to the author's statement, every piece of equipment described was first designed and then put to the supreme test of being built and operated by an average youngster. Thoroughly practical. (192 pages, 5½ by 8 inches, drawings and photographs.)—$2.10 postpaid.—*A. P. P.*

FIGHTING SHIPS OF THE U.S.A.

By Lieut. Victor F. Blakeslee

Main facts about the fleet, in relatively brief form, with the lesser technicalities omitted. A picture of daily life on Navy ships and of other aspects of the Navy and its functioning, such as the average non-technical person might ask about. Abundantly illustrated with color paintings. (76 pages, 9 by 11 inches, illustrated.)—$1.10 postpaid.—*A. G. I.*

HIGHWAY SAFETY AND AUTOMOBILE STYLING

By Arthur W. Stevens

An active member of the Massachusetts Safety Council, the author of this book has apparently made an exhaustive study of automobile design and its relation to highway safety. Briefly summarized, the aim of the book is to prove that safety on the highways of the United States cannot be increased, and the accident rate decreased, until automobile designers and stylists pay more specific attention to the safety phase of their work. (155 pages, 5½ by 8 inches, several drawings.)—$1.85 postpaid.—*A. P. P.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced."

JUST what is the present status of the 200" telescope mirror that is being made in California? What troubles have been encountered in the work, and how have these been dealt with?

From time to time the newspapers have stated a few facts—and some fancies. Three long articles in Scientific American (May 1936, November 1936, August 1938) stated many precise facts because they were written by the men who are making the telescope. Yet, even these did not fully satisfy those of this magazine's readers who are amateur telescope makers. This 10,000-sized minority of readers has wanted special, technical details not watered down for the general, non-telescope making reader.

This column therefore invited Dr. J. A. Anderson, who has lived with the actual work throughout, to describe the mirror part of it specifically for the amateur telescope maker, and in the lingo of the work. This is why the article presented is published in this department and not "up front."

The following is the first half of a two-part article by Dr. J. A. Anderson who, since 1916, has been chief optical expert at the Mt. Wilson Observatory and, since the start of the 200" telescope work, executive officer for it at the California Institute of Technology where the great mirror is being made.

"THE 200-inch mirror disk was cast at the Corning Glass Works in March, 1935, and arrived at Pasadena in April, 1936. The structure of the disk is indicated by the oblique photograph reproduced in Figure 1, showing the back and rim, and the diagram, Figure 2, showing a section along the line *AA* of Figure 1. In general it may be described as a continuous glass front supported by a system of glass ribs, so designed that when a concave curve is cut in the front surface (shown by the dashed line in Figure 2), the thickness of the glass shall be nearly the same everywhere. This construction was chosen in order to reduce the 'temperature inertia'[1] of the disk as a whole to a low value. It also makes it possible to bring the point of support of each supporting lever close to the center of gravity of the weight to be supported. For this purpose there are 36 circular openings in the rib system to accommodate the same number of supporting levers. Figure 3 shows one of the supporting units which is 'double-acting'; that is, it takes the place of both the ordinary back and edge supports.

"The work of shaping this disk into a finished mirror is not essentially different from that required for a smaller mirror familiar to all amateur telescope makers. Front and back must be ground flat and parallel to each other, and the edge ground to the form of a reasonably good circular cylinder. In addition, the 200-inch required that the 36 circular

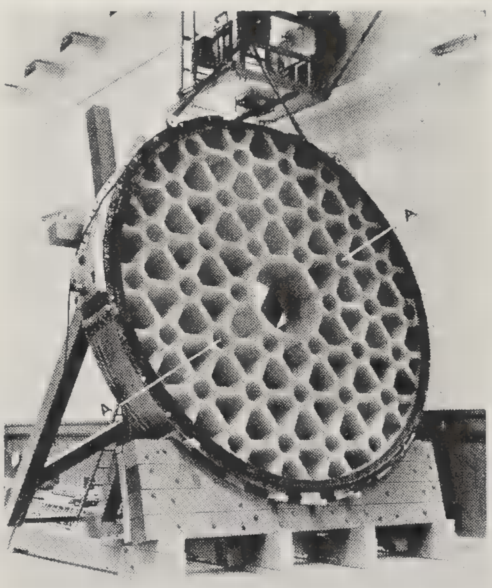


Figure 1: **Back of the big disk**

openings for the supporting levers be ground internally to very definite dimensions. An important difference arises from the great size and weight of the 200-inch; namely, that machinery is called for at every turn—and rather heavy and slow moving machinery at that.

"For the rough shaping a half-sized tool of cast iron was prepared. Its weight was about seven tons. It was made thick enough to be used first as a flat grinder and later on to be turned convex for roughing out the concave curve of the mirror. All other tools, including one of full size, were built up of thin sheet-steel plates welded together. These are much lighter than cast tools of the same size and they have also been found to be superior in rigidity. The working surfaces of these tools are covered with glass blocks which are used uncovered for grinding and covered with pitch substitute for polishing. The weight of the full-sized tool (shown on the floor to the left in Figure 4) is about five tons.

"In order to grind the back surface to a tolerably good plane, it was necessary to fill up the openings between the ribs. Little wooden tables were made and fitted into these openings in such a way that the tops of the tables lacked about 2" of being flush with the ribs. Plaster of Paris was then used to complete the filling. Only in this way was it possible to grind the surface to a true plane. This done, the cavities were cleaned of plaster and tables and the disk turned over in preparation for the next step, which was to grind the face plane and parallel to the back.

"Normally, this should have required a relatively short time, but actually it took many months, chiefly for the following reason: Corning had a considerable flood in 1935 while this disk was in the annealing oven. Water covered the floor of the room where the annealing was in progress to such a depth that it was necessary to shut off the current for about three days. A temperature drop of rather large amount was the result, but as soon as conditions permitted the temperature was slowly brought up to its normal value and held there constant for a time. Then the regular program of slow cooling was resumed. When, in late October 1935, the disk was examined, it was found quite successfully annealed, but there were some bad-looking fractures in the front surface. The immediate cause of these fractures was clear, for a couple of the chrome-iron I-beams of the cover had sagged enough to become partly imbedded in the hot glass and, as the cooling proceeded, strains due to the differential expansion of iron and glass did the trick. One has a feeling that this would not have happened if there had been no interruption in the cooling but, of course, this can now

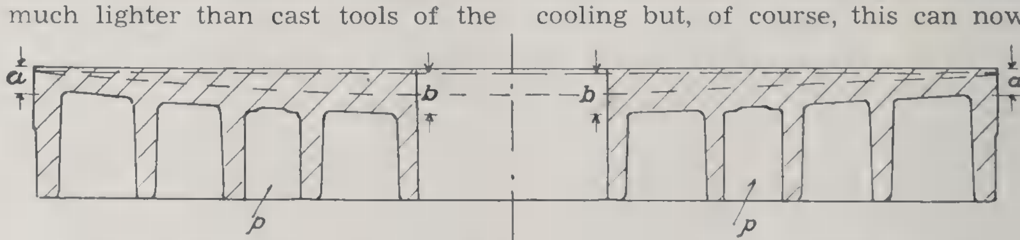


Figure 2: **Section along line *AA* in Figure 1. *p,p* are openings for supporting units. In the casting, thickness at *a,a* was 6", at *b,b* 9¾". In finished mirror (lower dashed line) thickness is approximately 4". Overall thickness at edge is 24". Finished weight, nearly 30,000 pounds**

[1] 'Temperature inertia' is a convenient term to indicate the length of time required for the temperature to reach equilibrium with the surroundings.

never be known with full certainty.

"The obvious thing to do was done; namely, to remove the fractures by sand blast and so find out whether sufficient thickness of glass remained to make a good mirror. The deepest excavation made in the sandblasting was over 5" deep but it was near the center of the disk, so it would still be possible to grind the concave curve and have a glass thickness of 4" left. If the disk had come out as planned, this thickness could readily have been 6" or a little more, which might have been an advantage if rigidity alone is considered. A thickness of 4" is, however, slightly better from the point of view of low temperature inertia, since all the ribs have about this thickness.

"It was decided that, instead of merely making the front surface into a true plane, the extra 2" of glass should be ground off before establishing the plane and making the disk parallel. This 2" of glass represented a weight of 2½ tons and used up five tons of coarse Carborundum. Later on, another 2½ tons of glass would have to be removed in cutting the concave curve.

"Grinding the edge was the next operation. This was done face down, with the face of the mirror raised some 8" above the turntable by inserting suitable timbers. The grinding was done with a rotating hollow cylinder of Carborundum fed with water and Carborundum powder. The 40" central hole was ground to size in this same set-up.

"The next step was grinding the 36 cylindrical holes designed to admit the supporting levers. The axes of these cylinders should be perpendicular to the parallel planes of the front and back already established, and, in addition, their spacing should be adjusted to form a regular geometrical pattern. A special 'pocket-grinder' had been prepared, carrying at its lower end a cast-iron hollow cylinder about 11" outside diameter. The rotating shaft carrying this cylinder could be given a slow motion in a circle having a radius variable slowly and accurately from nothing up to whatever the size required for the finished 'pocket.'

"The 36 pockets lie on five concentric circles, six on each circle except the fourth one (counting out from the center), which has 12. On circles 1, 2, 3, and 5 they are 60 degrees apart, while on the fourth circle they are spaced in six pairs 60 degrees apart, the members of a pair being separated by an angle a little less than 22 degrees. The whole operation of grinding these pockets was completed in about three months.

"Next the turntable of the grinding machine was covered with two layers of 1" sponge rubber and the mirror placed face-up on this bedding. In order to insure as uniform a support as possible the compression of each

TELESCOPICS

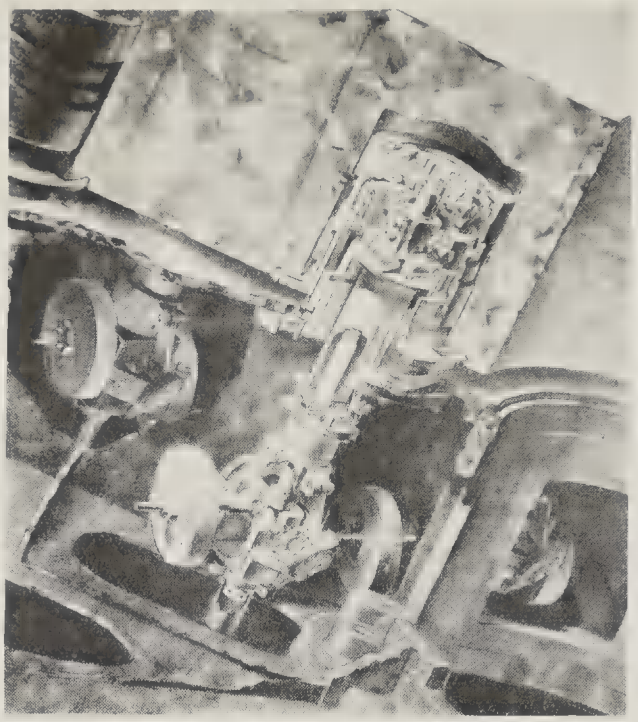


Figure 3: **Lever mirror support**

sheet of sponge rubber was carefully measured under a fixed load, and only those pieces whose compression was within a narrow range of being the same were applied to the table.

"The glass plug to fill up the 40" hole in the center of the mirror had been ground cylindrical to a suitable diameter, and it had to be inserted and fixed in place in such a way that, when the mirror is finished, it can be easily removed without any danger of harming the figure of the mirror. As the plug weighs about 1400 pounds, this did not look too easy. It was accomplished as follows: A wooden lifting clamp was applied to the upper half of the plug, leaving the lower ribbed section of about 15" projecting below the clamp. A cake of ice about a foot thick was placed on the table in the center of the hole. By means of the crane it was then possible to rest the plug on the cake of ice. The clamp was removed and the ice melted, thus lowering the plug gently into its proper position, after which it was fixed in place by means of plaster of Paris and waterproof cement.

"Before cutting the curve the support system was installed. This operation took approximately eight months. In preparation for it the weight to be carried by each of the 36 units had been calculated on the basis of careful measurements on the disk itself. Each support pocket was taken as the center of a hexagonal section of the disk. The hexagons around the central hole (Circle No. 1) and those adjoining the outer edge (Circle No. 5) are not complete, which fact complicated the calculations only slightly. The calculations furnished the weight to be carried by each unit and also located the center of gravity of each arbitrary section of the disk, thus giving the necessary data for each counterweight and for locating the internal points of application of the supporting force. Each support (Figure 3) was carefully adjusted and tested on a weight equal to that which it was intended to carry before it was attached to the mirror and its cell. Provision was made for temporarily disconnecting all the supports when work was in progress with large tools. They were, however, connected properly when an optical test was to be made.

"The curve was roughed out with cast-iron tools of about one third size, and brought to approximately correct form by means of the half-sized tool already mentioned, after which the glass-coated full-sized tool and the finer grades of Carborundum and emery finished the grinding. Measurements of curvature were made with a 36" spherometer. Next, the full-sized tool was changed to a polishing tool, as already explained, and the surface brought to a nearly full polish. It was found that the full-sized tool used up rouge at the rate of some 50 pounds per hour, mostly by simply splashing it over the edge, hence subsequent polishing and figuring was done with smaller tools—106" and down to about 12"."

Next month: Troubles. Tests. This part will explain the delays that puzzled the public: the disk developed a case of curable ptosis.

Figure 4: **Five-ton, full-sized steel tool. Grinding and polishing machine in rear**

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

DEVELOPMENT of the destroyer in the navies of the world has been such that today no other fighting ship is depended upon to carry out so many varied tasks. The work of these versatile naval vessels is described in detail in the article starting on page 55.

SCIENTIFIC AMERICAN

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NINETY-EIGHTH YEAR • ORSON D. MUNN, Editor

FEBRUARY · 1942

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OUR *Point* OF VIEW

CIVILIAN DEFENSE

In the kind of war we are fighting today civilian protection is necessary because this is an "all-out" war, a "total" war, an "everybody's" war — and there's nothing new about it. It is as old as mankind. In fact, we have Mr. Schicklegruber's statement for it that one objective of this kind of a war is "the disappearance of the vanquished people from the stage of history." Accordingly, as everyone now knows, total warfare is waged not only against the armies and the navies and the air forces, but the civilian men and women as well, to say nothing of the children and the old people. That's why we must consider civilian protection. That's why we are faced with the necessity of perfecting organizations to minimize the effects of air-raid damage, to prevent hysteria, and above all to save civilian lives.

To accomplish this, the United States Office of Civilian Defense was established by Executive Order on May 20, 1941. It was assigned the job of preparing and organizing a means of defense against the horrors of hostile attacks on the unarmed portion of the nation by air or otherwise. To this end Civilian Defense basically has been shaped up on a "neighbor-help-neighbor" policy—a volunteer program as broad as the United States itself and as American as Lexington's Minute Men.

Contrary to public opinion in many quarters, the Office of Civilian Defense had made remarkable progress prior to Sunday, December 7, 1941. Before the bombs fell on Pearl Harbor, too many of us were of the opinion that "it can't happen here," and as the growth of the many-sided plan depended entirely on volunteer action on the part of the people it was designed to protect, its efficiency was stultified. After Pearl Harbor—who among us didn't ask the questions, "What can *I* do? Where do *I* fit in?"

The answer is simple. The three broad categories of help in this war are: Armed forces, productive forces, and civilian defense. The first needs no amplification. The second includes necessities of civil life such as groceries, clothing, and fuel, as well as planes, tanks, guns, and shells. For the third, volunteers — thousands upon thousands of them — are needed in every community, whether large or small. There's room for everybody in Civilian Defense, and everybody is sorely needed, from doctors and nurses to file clerks and publicity experts; from dietitians to telegraphers; from air-raid wardens to sanitation experts. Ignorance of the requirements needed to fill a civilian defense job is no excuse. There are now thousands of classes being conducted daily and nightly by competent instructors in every phase of this vast program of help. Westchester county, for example, just north of New York City, has trained 30,000 of its residents as defense workers. Business men who commute to the city by day stand guard over aqueducts, pumping stations, and the like by night, while their wives graduate from Red Cross First Aid courses or maintain constant watch of the sky at aircraft warning posts.

It's the same all over the country. The Office of Civilian Defense has established nine regional offices —coinciding as to area and jurisdiction with the nine Army Corps Areas—and 48 state organizations, each of the latter being headed up by the governor and members of his state defense council. From there on down to the smallest community or rural area, a civilian defense council has been or soon will be established, and in each case it will be led by the head of the civil governing unit—the mayor of a city or village, the selectmen, the township or county supervisors. All existing services, such as firemen, police, and public utility repair crews will be used as nuclei for the organization of larger groups. The American Red Cross is the only organization accepted as an entity; all other enlistments must be voluntary and must be individual in nature for reasons that are obvious. A men's civic club, for example, may enroll each individual member—presumably in the service for which he is best fitted—rather than joining en masse as an ambulance corps, or a decontamination squad, and so on.

One authority has stated that in the last war Germany devoted approximately 50 percent of her civil resources and energy toward winning the conflict. Today, it is estimated that better than 80 percent of all German civil existence is unalterably linked with active furtherance of Mr. Schicklegruber's ambitions. On the other hand, England is said to have attained to about 40 percent of potential civilian effort toward wrecking those ambitions, yet the United States today can claim but 15 percent active civilian participation. It has also been said that German leaders, advocating a truly all-out civilian participation in war effort, estimated that such additional impetus would this time tip the scales in favor of victory.

There can be no doubt but that the people of the United States can organize, build, and maintain the greatest civilian war effort the world has ever seen—if they have a mind to do so. The Pearl Harbor catastrophe placed the stamp of action in millions of minds hitherto inactive on this subject, but we are still a long haul from 100 percent civilian co-operation. There's a branch of the United States Office of Civilian Defense in your neighborhood.—*A. D. R., IV.*

WAR-TIME GARDENS

The United States Department of Agriculture is to be commended for calling a nation-wide conference to discuss and formulate a broad, co-ordinated program for enlistment in and guidance of a national campaign to encourage farm, home, and community gardens as a defense measure. If the goal for 5,760,000 farm gardens under controlled planting is even partially achieved in 1942, we shall all be healthier through better food habits, our home food supplies will be improved, and we'll try not to be hysterical this time and dig up golf courses and flower gardens in favor of potatoes!—*A. P. P.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of February, 1892)

OIL—"To-day the petroleum industry represents one of the greatest industries of the world. With gas and the electric light to compete against as illuminants, it is every year acquiring more importance, and holds a position as one of the three great sources of artificial light. . . In 1862 and 1864 the first suggestions toward transporting oil by lines of pipe were made, and in 1865 a pipe, 3,200 ft. long, was laid from Pithole toward Oil Creek, at Miller Farm. It could pass 81 barrels a day. . . At the present day the

Central oil refinery at Cleveland

entire oil region is covered by pipe lines. . . Transportation trunk lines have been laid to New York, Philadelphia, Baltimore, Cleveland, and other points. These lines are for the most part owned by the National Transit Co., which is, really, a branch of the Standard Oil Company, which controls practically all of the refineries, as well as the oil business of the United States."

CABLE—"The preliminary survey of the Hawaiian cable has been nearly completed. The *Albatross* has laid out a line from Salmas Bay across the Pacific. . . The line laid down by the *Albatross* on its outward trip is slightly north of that laid down by the *Tuscarora* fifteen years ago. Several submarine peaks were encountered, but the bottom is for the most part regular and suitable for the bed of a cable."

ELECTRICITY—"High authorities cannot even yet agree whether we have one electricity or two opposite electricities. The only way to tackle the difficulty is to persevere in experiment and observation. If we never learn what electricity is, if, like life or like matter, it should remain an unknown quantity, we shall assuredly discover more about its attributes and its functions."

AIRPLANES—" 'So far as the mere power to sustain heavy bodies in the air by mechanical flight goes, such mechanical flight is possible with engines we now possess.' These words, coming as they do from Prof. S. P. Langley, carry with them the weight of authority. Nearly five years ago, Prof. Langley, then the director of the Observatory at Allegheny, Pa., commenced there a series of experiments in aerodynamics. . . 'I am not prepared to say that the relations of power, area, weight, and speed, experimentally established for planes of small area, will hold for indefinitely large ones; but from all the circumstances of experiment, I can entertain no doubt that they do so hold far enough to afford assurance that we can transport (with fuel for a considerable journey and at speeds high enough to make us independent of ordinary winds) weights many times greater than that of a man.' "

CAMELS—"Neither the most broiling heat nor the most intense cold nor extreme daily or yearly variations hinder the distribution of the camel. It seems, indeed, that the dromedary of the Sahara has better health there than in more equably warm regions; though, after a day of tropical heat, the thermometer sometimes goes down several degrees below the freezing point, and daily variations of 90 degrees occur."

ALUMINUM—"Taking into account the development made by the factories of aluminum in recent years, it may well be believed that the production almost equals the demand, although new uses for this light but ductile metal are being daily discovered. . . Toward the middle of last year American aluminum was quoted at a rate of $2 per lb.; some few months later the price was reduced to $1 per lb. The present prices are: For No. 1 quality, 90 cents per lb. in small quantities and 75 cents per lb. for orders of at least one ton; for No. 2 quality, of a purity of from 94 to 97 percent, 65 cents per lb. for quantities of not less than a ton. These prices are quoted by the Pittsburgh Reduction Company."

TIME SIGNALS—"Some interesting experiments have been made by Mr. W. P. Gerrish on distributing time accurately by flashes of magnesium powder. Signals were thus sent from a station on Blue Hill, Mass., twelve miles distant. They were readily visible, and the exact time to within a fraction of a second could be taken from them. These flashes were also seen from Princeton and Mount Wachusett, forty-four miles distant, and from numerous nearer points."

INSANITY—"In the brain of a woman who had a visceral delusion, that was almost her sole idea, to the effect that a tape worm found a lodgment within the internal organs and came and went at pleasure, there was unilateral hypertrophy of the paracentral lobules, those in one hemisphere remaining perfectly normal. The patient was perfectly lucid and rational on all subjects except this one delusion, though it was difficult to induce her to speak of any other."

PEACE-WAR SHIP—"A new gunboat, the *Svensksund*, has been added to the Swedish navy. . . The vessel will, however, be more useful in time of peace than in war, as, first, she is a powerful ice breaker, fitted with water tanks for sinking to the desired depth; secondly, she is furnished with heavy gear for towing or hauling off stranded vessels; thirdly, she is equipped as a fire steamer, having ten large suction hoses and a centrifugal pump capable of delivering 22,000 cubic feet of water per hour; fourthly, she is fitted with condensers furnishing 800 gallons of water per hour; and fifthly, she is equipped as a torpedo repairing vessel."


SERVICE
TO THE
NATION
IN
PEACE
AND
WAR

A LABORATORY "THUNDERCLOUD" TO AID AVIATORS

LABORATORY study of atmospheric electricity is yielding facts that are being translated into practical instruments for use by aircraft pilots. The experimental set-up of a "cloud charge indicator for airplanes," shown above and described in detail on page 78, has resulted in the design of an instrument weighing only two pounds that will furnish a pilot with an indication of the electrical intensity in the air ahead, thus enabling him to decide whether or not he should change his course.

98TH YEAR SCIENTIFIC AMERICAN FEBRUARY 1942

'MAID-OF-ALL-WORK'

Place of the Versatile Destroyer in Modern Navies

WALTON L. ROBINSON

WITH the possible exception of the stealthy submarine and the tiny, ultra-swift motor torpedo boat, there is no class of warship whose past and present exploits have been more daring than that "Maid-of-all-work"—the torpedo-boat destroyer. Originally conceived to combat torpedo boats (hence its name, now shortened to simply "destroyer"), it soon took over their duties and later assumed several additional ones, with the result that today no other fighting ship can carry out so many varied tasks. With its armament of torpedoes, depth bombs, and guns, the destroyer must now be reckoned with by the enemy's forces on, under, and above the sea.

In a general fleet engagement destroyers are indispensable for attacking and screening duties, while on detached or independent service they are extensively used for such important work as laying and sweeping minefields, raiding enemy commerce, escorting convoys of merchant vessels, and waging a ceaseless campaign against the marauding submarine. It is to fulfill these last two missions that the United States and Great Britain so urgently need every destroyer that can possibly be built.

Modern destroyers vary greatly in size and strength of armament, but all of them are swift, handy craft, able to face seas which quickly would have forced the boats of a few decades ago to seek shelter in port. Those displacing less than 1000 tons are now generally classed as torpedo boats, while the relatively few of more than 2000 tons are, in reality, small, very fast light cruisers. France, Italy, and Russia are the only powers which possess these "super-destroyers." What may be considered the destroyer proper is a boat displacing between 1000 and 2000 tons, able to attain a speed of 33 knots or more, and armed with four to eight guns of 4.7-, 5-, or 5.1-inch caliber (diameter of bore) and four to sixteen torpedo tubes. All of Britain's modern destroyers mount 4.7-inch guns (four, five, six, or eight in number) and most of them have eight or ten torpedo tubes. Germany's *Grosse Torpedoboote* ("large torpedo boats") have a uniform armament of five 5-inch guns and eight tubes. Italian *cacciatorpediniere* ("torpedo boat chasers") are noted for their very high speeds (39 knots in the newest units), but have only four or six 4.7-inch guns and a correspondingly weak torpedo armament. Japanese *kuchikukan* are rather slow (34 knots), but are reasonably well armed; they carry four to six guns and from six to nine torpedo tubes.

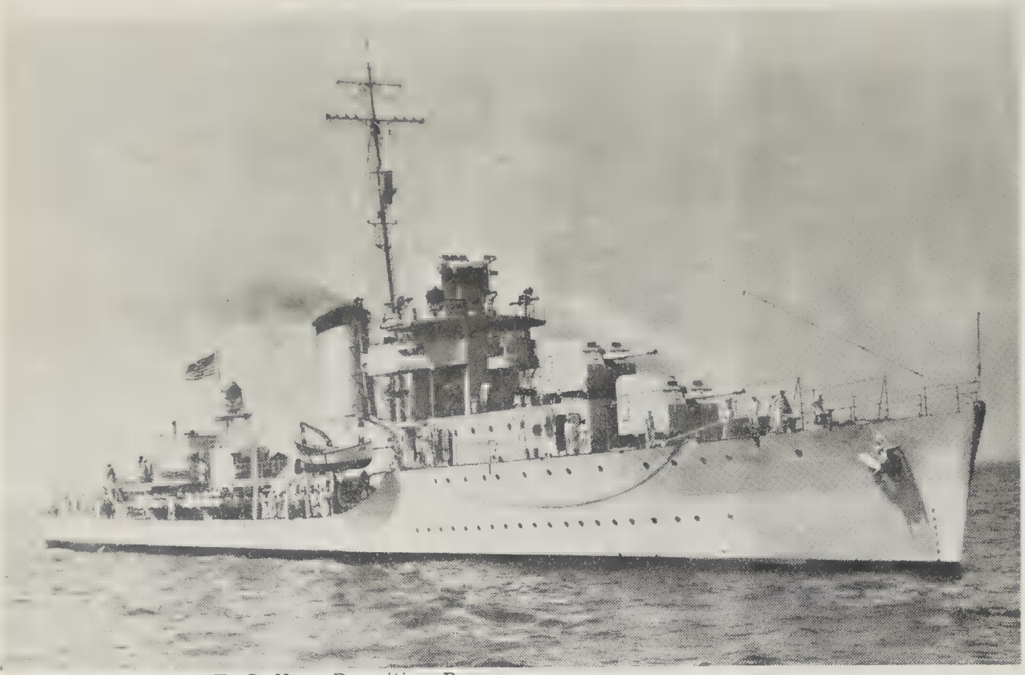
NATIONAL DEFENSE

● INTEREST in destroyers was enhanced when, last year, the United States sent 50 of these singular warships to Britain. Attacks on the *Kearny* and the *Reuben James* focused the spotlight more clearly. As this is written, Pacific naval warfare has thrust this branch of our Navy into a leading role. Just what are destroyers? How large are they? What are their duties? Why do we and Britain need them so desperately? In these days of history-on-the-blitz, one hardly knows what turn may be taken by the time an article appears in print. Nevertheless, this story essays a reply to the above questions. —*The Editor.* ●

American destroyers have always been remarkable for their very powerful torpedo armaments. Some of our most recent units are provided with as many as sixteen tubes, while even the "flush deckers" of 1916-19 vintage boast twelve. All of our under-age boats, the oldest of which were begun in 1932, mount eight, ten, twelve, or sixteen tubes and from four to eight 5-inch "double purpose" guns, so called because they can be employed against aircraft as well as warships. Our largest destroyers, the five of the *Somers* class, displace 1850 tons and carry eight guns and twelve torpedo tubes. Designed to operate as squadron leaders, they are among the most powerful vessels of their type afloat.

THUS, we have an outline of the destroyer's principal characteristics and can now examine its tactical possibilities in modern warfare. First come its various duties in a fleet engagement, then its several forms of employment on detached service. In either case the destroyer's work may be of an offensive or defensive character, though in the performance of the latter, action of an aggressive nature is often required.

In a major fleet battle the destroyer has two offensive missions to fulfill. The principal of these is to carry out torpedo attacks on the hostile battleship column. To be most efficacious, such attacks must be delivered by one or more squadrons (flotillas), supported by cruisers to assist in piercing the protective screen of enemy light craft. On arrival within effective range, say 6000 yards, each destroyer will carefully calculate the



All photos courtesy U. S. Navy Recruiting Bureau

A typical American destroyer: 1500 tons, speed 36.5 knots

enemy's course and speed, will discharge all or most of its torpedoes, and then retire at full speed under cover of dense clouds of smoke. Such attacks *en masse* are far more likely to achieve success than isolated ones made haphazardly by only a few boats, for the more numerous the torpedoes approaching an opponent's battle line, the more difficult will it be for his ships to avoid them. Two squadrons of our modern destroyers—a total of 18 boats—could launch at a given signal over 100 torpedoes, and this number of "tin fish" rushing simultaneously toward an adversary's column of dreadnoughts should score a high percentage of hits. One or two hits on a ship would cause it to lose speed and probably to leave the battle line, while several more would most certainly send it to the bottom. The value of the torpedoes discharged in such an attack would amount to considerably more than a million dollars, while a number of the participating destroyers would likely be sunk or badly damaged. Should the present war produce a large-scale naval action, say between the British and Italian fleets in the Mediterranean or between the United States and Japanese fleets in the Pacific, such massed attacks by surface torpedo craft would undoubtedly play a prominent part and might well decide the issue.

The destroyer's other offensive function in a fleet battle is the laying of what are termed tactical minefields. An operation of this nature was carried out at Jutland by H.M.S. *Abdiel*—a destroyer with its torpedo tubes replaced by mine racks. During the night this boat laid mines in advance of the retreating enemy fleet, but the Germans altered course and avoided the newly sown minefield, of whose existence, however, they were completely unaware. Despite the failure of the tactical minefield on this occasion, the idea was an excellent one deserving of success. That this form of warfare is considered to hold much promise is indicated by the fact that practically all navies possess a number of destroyers fitted for minelaying. The Italian and Soviet navies are especially enthusiastic about its possibilities and the vast majority of their destroyers are equipped to lay mines.

THREE vitally important defensive tasks fall to the lot of destroyers assigned to the battle fleet. During a major operation, and while the fleet is still in cruising formation, destroyers must screen the great dreadnoughts from possible submarine attack. In the performance of this mission they rely chiefly on the depth bomb. In the present conflict Italian submarines in particular have attempted frequently to interfere with the British Fleet's movements in the Mediterranean, but their successes thus far have been out of all proportion to their heavy losses. Not a single British battleship has been sunk by Italian submarine action, and only one is believed to have suffered damage.

Soon after contact with the enemy's fleet has been established, destroyers will be called upon to repel hostile torpedo attacks and to lay protective smoke screens. They can best accomplish the former task by dashing out and engaging the attacking flotillas before they arrive within effective torpedo range. Both sides will dispatch cruisers to support their destroyers and much hard fighting will ensue. The result of this secondary action will exercise a profound influence on the course and outcome of the battle raging between the big ships.

SMOKE screens are employed to conceal from the enemy some intricate maneuver or to protect a badly damaged ship. They are invariably resorted to by a fleet wishing to withdraw from the action. In the engagement off Punto Stilo on July 9, 1940, between the Italian and British fleets, the former and inferior force succeeded in escaping almost certain disaster by retiring at full speed behind dense curtains of smoke emitted by a destroyer flotilla.

Tactical scouting with other advance units of the fleet is yet another duty which falls to the destroyer, for there will never be sufficient cruisers to do this work, while bad weather or lack of carriers or nearby shore bases may preclude the effective use of aircraft. During the past two years there have been several naval actions in which planes were unable to participate due to one or more of these reasons.

Of the destroyer's several duties on detached service, anti-submarine operations are by far the most important. These may take the form of escorting large convoys of merchant vessels, patrolling defined danger zones, or laying mines at the exits of the submarine bases. In the first two cases the destroyer's most effective weapon is the depth bomb, although occasions may arise in which gunfire, torpedoes, or ramming tactics can be employed. Depth bombs were invented during the last war and proved so successful that they now form part of every destroyer's armament. They are either rolled overboard from racks at the stern or are discharged from a projector known as a "Y-gun." Detonation at practically any desired depth is effected by hydrostatic pressure. The explosive force of the 300-pound charge of trinitrotoluol—TNT—will destroy or seriously damage an undersea boat within a radius of seventy to one hundred

feet. Even if the submarine is not sunk or badly damaged, it is probable that the morale of its crew will be so shaken as to necessitate an early return to port. Many submarine crews have testified to the demoralizing effect of a barrage of depth bombs exploding near their craft.

DEPTH bombings are today far more likely to achieve success than was the case 25 years ago. Their increased effectiveness is due in large part to improved methods of detecting a submarine's presence and exact whereabouts beneath the surface. In the last war the only device for such work was the hydrophone, which located the undersea craft by picking up the sound of its motors. In those days, consequently, all that a U-boat had to do after attacking an escorted convoy was to rest on the bottom with motors quiet. Nowadays, however, the problem confronting an Axis submarine commander is much more difficult, for in the years between the last war and the present one the British invented a truly marvelous submarine detector. Popularly known as the "Asdic" (after the Anti-Submarine Detection Investigation Committee), it can locate a submarine lying on the bottom almost as readily as it can one which is under way. The "Asdic's" very existence was among the Royal Navy's most closely guarded secrets prior to the outbreak of war, and the Germans did not discover how it functioned until after the fall of France, when they examined a number of French destroyers.

In the present conflict the Axis navies have lost a very considerable number of submarines. It is impossible to state the precise extent of their losses, but about one hundred German *Unterseeboote* and nearly half that number of Italian *sommergibili* are believed to have been destroyed. The majority of these boats were sunk by depth charge attack, while mines and aerial bombing accounted for most of the others. Axis destroyers, mines, and planes have taken, of course, their own toll of British and allied undersea boats. During the first two years of war the Royal Navy alone lost 29 submarines by enemy action. While the exact fate of most of them remains unknown, it is safe to assume that fully half were sent to the bottom by depth charges. Several, however, were sunk by ramming. Such tactics, incidentally, often result in considerable damage to the destroyer's bow—sufficient in most cases to put her out of service for several weeks.

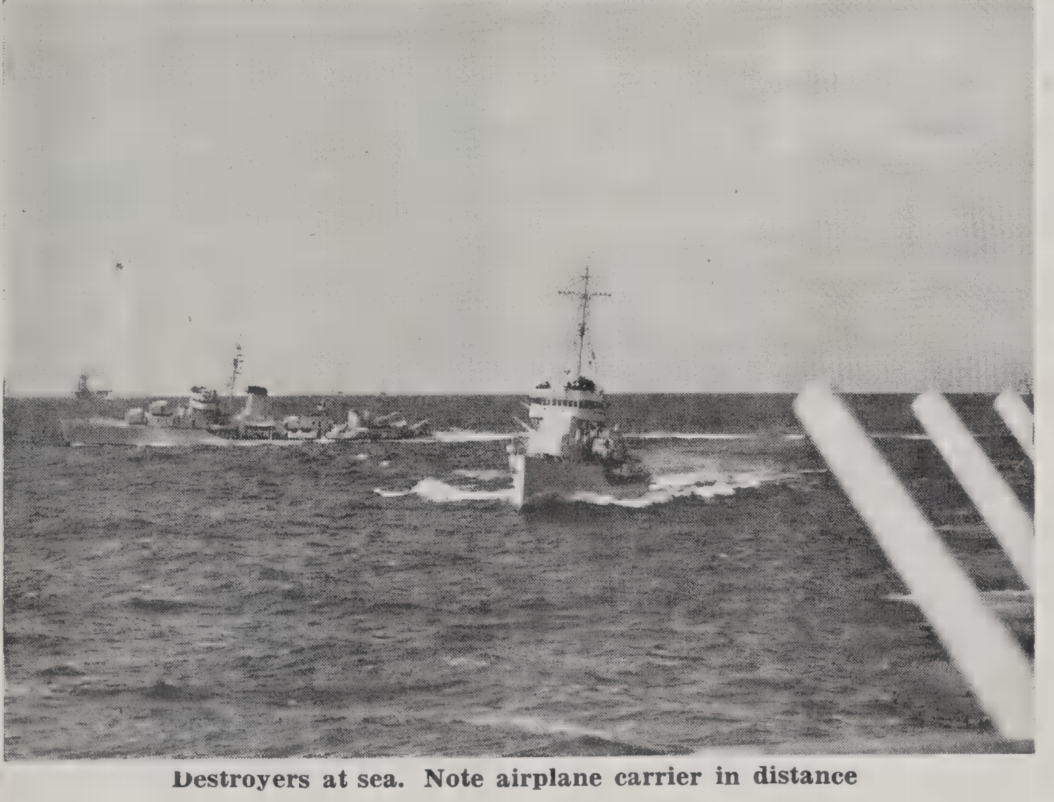
Minesweeping is a very important and extremely dangerous task which destroyers are sometimes called upon to perform. They should not be employed in this work, however, except in emergency, for they are too valuable and needlessly large and fast. Smaller, less costly craft, either specially built or converted, can discharge this duty in an equally efficient manner.

Destroyers maneuvering

COMMERCE raiding is yet another mission which destroyers can carry out. Prior to the outbreak of the current war, this work had been entrusted almost exclusively to cruisers. Britain's perennial shortage of cruisers has obliged her, however, to dispatch destroyers to assist in the capture or destruction of those enemy merchant vessels which from time to time slip out of neutral ports in an effort either to supply some raiding warship on the high seas or to run the blockade and return home. This task the fragile destroyers of 1914 were incapable of performing, but the modern ones, with their wide radii of action and splendid sea-keeping qualities, have had little or no difficulty in carrying out such assignments.

That destroyers are constantly being employed on service of the most hazardous nature is evidenced by the great number which have been sunk during the past two years. Excluding small units of less than 1000 tons displacement, over 100 destroyers have fought their last action. Numerically, Britain heads the list with some 50 lost, while Germany and Italy have suffered even more heavily in proportion to the size of their navies. (At the time of writing it is still too early to give accurate and official data on losses in the "Battle of the Pacific.")

Britain's losses represent about



Destroyers at sea. Note airplane carrier in distance

A division of destroyers in tactical exercises

30 percent of her destroyer forces available in September, 1939. Since then she has strengthened her navy by at least 80 destroyers, including the 50 acquired from us. Thus Britain's present-day strength comprises over 200 destroyers. This number is far from adequate, however, for Germany now has in service many more U-boats than was the case two years ago. At that time some 70 Nazi submarines were ready for sea, while today probably twice that number are operating against Britain's vital sea communications. Moreover, Germany is building U-boats at a furious pace: our Navy Department estimates that she is rushing work on nearly 200. The collapse of France and Italy's entry into the war have also done much to increase the Royal Navy's difficulties, for the French possessed about 70 destroyers and torpedo boats, while the Italians added more than 100 submarines to the enemy's strength.

The coming months will doubtless witness much bitter naval fighting as the "Battles of the Atlantic and Pacific" rage between German, Italian, and Japanese undersea craft on the one hand and the anti-submarine forces of the United States and her allies on the other. In this life and death struggle the destroyer will assuredly share many of the honors. Perhaps some new missions will be discovered for it, though what they might be defy the imagination, as already it is capable of such varied service. Well, indeed, has the destroyer earned the sobriquet: "Maid-of-all-work."

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Inch by Inch, Tooth by Gear

Army Officers Receive Technical Training in Motor Vehicle Operation and Up-Keep

FROM Second Lieutenant to Lieutenant Colonel, officers of the streamlined, motorized divisions of our fast growing Army are attending each week in Detroit a school conducted by Chrysler Corporation in advanced technical training in the operation and maintenance of the thousands of speedy, sturdy motor vehicles in which our present-day fighting forces ride instead of march in maneuvers and in cantonment routine at speeds up to 50 miles an hour.

Each Monday morning at 8 o'clock sharp, officers from the Army posts scattered across the country assemble in the Army School class room. During the first half-hour they are registered and given their schedule of intensive training for the week.

Actual school work starts promptly at 8:30. The men are divided into four groups, each under the supervision of a trained instructor, an experienced, qualified, automotive service specialist. Two full hours are devoted to the subject of wheel alignment. Each officer is instructed and given actual practice in the mechanics of caster and camber of front wheels. They learn the meaning and importance of proper wheel alignment—the effects of misalignment. Each man is given an opportunity to check the wheels with special gages. They discuss causes and effects informally but thoroughly.

From 10:30 to 12:00 o'clock each group probes the intricacies of an Army truck's electrical system—its nerve structure. They "dissect" the generator, examine its insides, check the wiring, the condenser, distributor, and all the elements that are a part of or affect the electrical apparatus.

Lunch period is from 12:00 to 1:15 P.M. Shop work continues from 1:15 to 4:00 o'clock. The men disassemble and reassemble brake mechanisms, make brake adjustments, bleed the lines of the hydraulic brake system. They discuss the common and uncommon causes of brake trouble, excessive wear and other complaints.

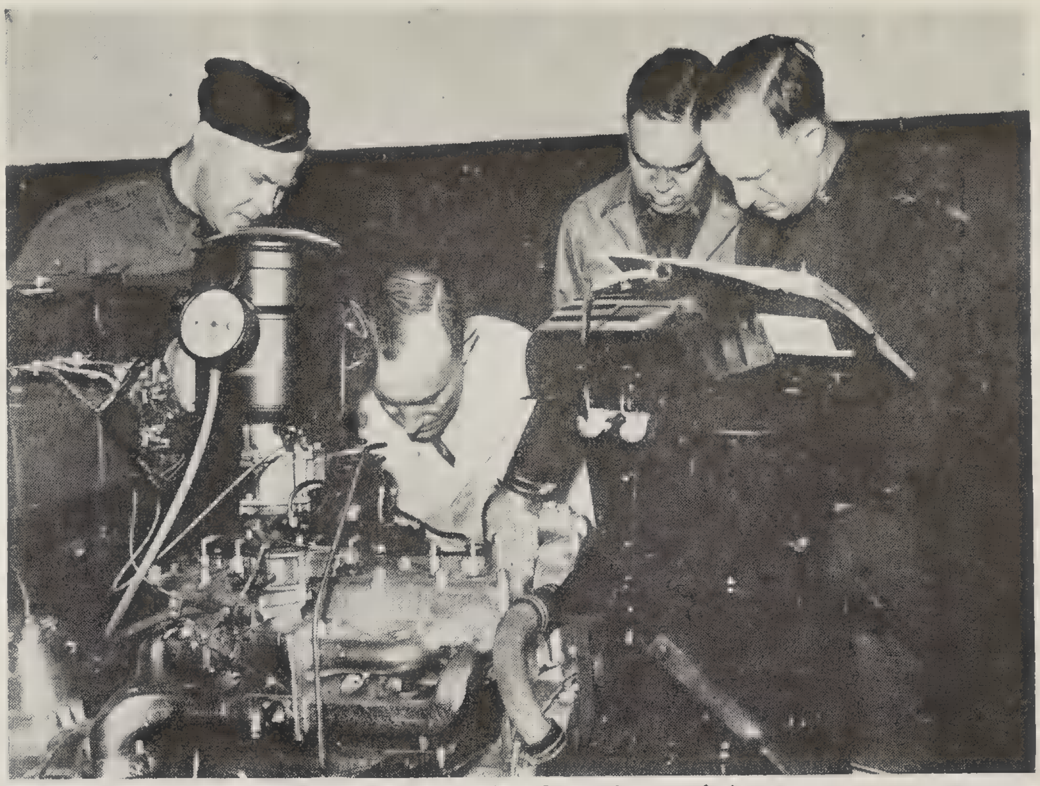
From 4:00 to 4:30 P.M. they return to the class room for a question-and-answer period to clear up any misunderstanding or details that might not be clear in the mind of any man regarding the subjects covered during the first day of the school.

On each succeeding day the hours for discussion in the class room and shop work at the benches are about the same, but during each period a different subject is taken up. At the end of the week, when the officers depart for the return

Army trucks go through their paces

trip to their respective Army posts, they have gone over, inch by inch and tooth by gear, the vital mechanical parts of the Dodge Army trucks that are being turned out by the thousands in various types for Army use.

From beginning to end in all instructions, in all theory, in shop work, and in discussions, preventive rather than corrective maintenance is stressed with all possible emphasis. "A stitch in time" is what keeps the Army rolling. The men and the weapons and the supplies of a modern, fast-moving Army can't stop and wait for a truck to be repaired. When a vehicle fails and can't keep going, it is simply left by the wayside and the Army rolls on.



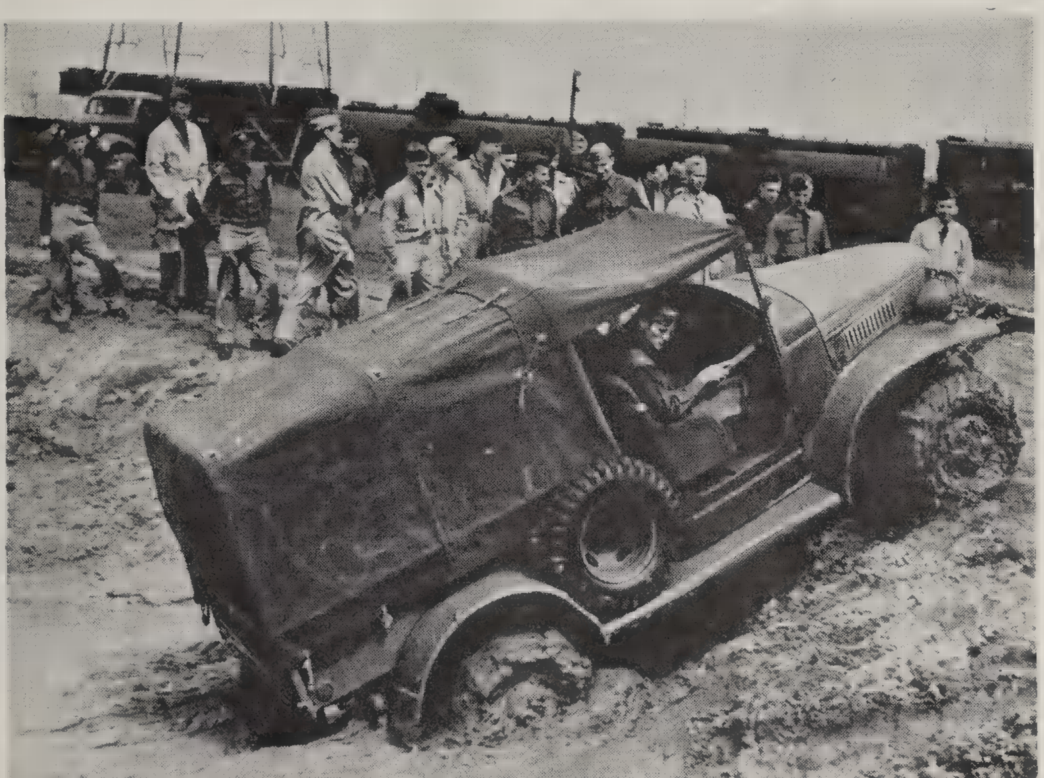
Army officers learn truck motor maintenance

The officers are taught to become familiar with the sound of engines, transmissions, differentials, generators, and various other moving parts so they can detect the noises that are apt to mean trouble. Impending trouble detected by the sound of a vital unit usually can be corrected before serious damage results, thus preventing failure or delay.

A highlight of the training course is the "scrambling" of an engine. The timing gears, carburetor, electrical apparatus, and all possible units and attachments are purposely thrown completely "out of kilter." Each man takes his turn "unscrambling" the mess, putting each part back in proper adjustment and working condition.

Practical training in driving Army trucks in rough going on a specially constructed testing ground adjoining the Dodge truck plant near Detroit forms the spectacular and exciting part of the training course. Each Wednesday afternoon is devoted to a driving field day for the Army men. The officers take turns driving the reconnaissance cars, command cars, weapon carriers, troop transports, cargo transports, and ambulances over precipitous grades of 60 percent and more, through a veritable mud-wallow in which the wheels of the trucks drop practically out of sight, over rutted fields and bogs, and through second-growth brush.

Each Friday afternoon the officers are taken on a tour of the corporation's engineering laboratories, where they see how the important parts of the motor vehicles are tested in a thousand ways to duplicate days, weeks, months, and years of stress and strain.



Officers at school drive a truck through a mud wallow

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SMOKELESS POWDER

Chopped-Up Cotton

Speeds Production

Cotton linters, the fuzzy threads left clinging to cottonseed hulls after ginning, has always been the best material for use in the preparation of smokeless powder. Present-day demands for powder production, however, have long since consumed the available supply of linters. Other cotton fibers are too long to use in powder production since they tend to "spin" or "rope" in the nitrating machinery and clog the works.

Now, however, long cotton fibers can be reduced to an approximation of the length of linters by new machines invented by United States Department of Agriculture engineers. The long cotton fibers are first reduced to medium lengths which in turn are sent through a second machine where the fibers are chopped into the equivalent of linters.

Shutters and Cutters

High-Speed Motion-Picture Photography Used in Study of Machine-Tool Cutting Edges

B. L. McKENZIE

HIGH-SPEED photography, famous for its trick shots of golf strokes, tennis strokes, and the like, may soon become equally famous for its value to industry as an aid in determining how to bring closer to perfection the design and the performance of milling cutters, lathes, planers, and many other similar machine tools. Such is the conclusion to be drawn from an experimental series of photographs made by this method in the course of the past year.

Until a short time ago, very little was definitely known about the action that takes place at the cutting edges of machine tools. It was known, for example, that chips cut from certain materials break off and are thrown clear of the cut, whereas in other cases the chip is removed in a continuous curled strip; that a certain amount of distortion takes place in the material cut away; that abrasive action on the tool occurs during cutting; that in dry cutting there is a tendency toward a welding action between the chip and the tool face; and that a certain amount of chatter in the machine is present at times.

But because the action of machine tools is far too fast to be seen and studied by the naked eye, it was formerly impossible to determine exactly what does take place at the cutting edge. In an effort to gain knowledge on this subject, the General Electric Company developed the necessary lighting equipment to make—and then made—the series of high-speed machine tool photographs.

In the high-speed camera adapted to the purpose, an Eastman Kodak type II, exposures are controlled by a shutter, and images are moved with the continuously moving film by means of a revolving prism, which is used in addition to the objective lens.

Using 16mm film, and operating at a speed of 1000 frames per second, 100-foot spools were exposed in four seconds, the footage exposed in one second requiring one minute to view when projected at normal speed. Built into the camera was a delicate pair of timing dials which, controlled by a 200-cycle tuning fork, indicated respectively seconds and thousandths of a second, and were photographed on the right-hand edge of each frame, rendering an accurate account of the amount of movement taking place in a given amount of time.

Set-up for taking high-speed photographs of machine tools, to study action at the cutting edges

Principal problem in making the high-speed pictures was that of sufficient light. Since the largest practical lens aperture that could be used was about $f/2$ and the exposure time approximately 1/4000th of a second, a light approximately five times the strength of sunlight was required to produce a clear image on the negative.

Work on the series of pictures was done at night and during weekends to avoid vibration from neighboring machines. Two high-power lamps were trained directly on the area being photographed, one lamp being placed at each side of the camera to eliminate confusing shadows. Since action in these cases was localized in a very small area, it was possible to place the camera close enough to the work to make pictures of areas one-inch square and ¼-inch square, thereby permitting movement measurements to within a few thousandths of an inch to be made, on examination of the finished pictures, with a fair degree of accuracy.

The workpieces from which chips were cut were marked in squares 1/32 of an inch on a side, to facilitate study of the material both during the cutting process and afterwards, and to permit identification of the metal in chips with regard to previous location in the block of material.

TOOLS studied in the photographic series were milling cutters and planers, used without coolant, an effort being made at all times to simulate normal operating conditions — normal operating speeds and feeds. A narrow workpiece was selected for cutting, in order that all of the separation of the chip from the block would take place at one cutting surface. Thus the action observed at the side of the workpiece was the same as that taking place throughout the width of the cut, and in addition — since chip action was in a vertical plane — an unobstructed view of the work by the camera lens was possible.

In photographing conventional milling, materials cut were SAE 1020 steel, of Brinell hardness 160; yellow brass, Brinell hardness 130; and cast iron, Brinell hardness 170. Standard milling cutters were used, at a speed of 37 surface feet per minute, taking a 3/16-inch cut, with a table feed of 30 inches per minute. In photographing climb milling, materials cut were SAE 1020 steel and ascoloy. Cutting speed for the climb milling process was 42 surface feet per minute, with a seven-inch per

The three high-speed photographs above show a milling cutter cutting cast iron. The characteristic segmental chip of cast iron is evident. In picture at right, chip has been detached from work. Note 1/32-inch cross markings on workpiece. Photograph below shows planer cutting brass. Distortion of work is shown by the cross markings, which serve as indices for study

minute table feed, the cut taken being the same as in the conventional milling photographs — 3/16 of an inch. Various types of standard cutters were used for these operations.

For the purpose of further study, special cutters were then ground, and photographed at work. The first of these, designed to show the difference in cutting action between sharp and dull teeth, was ground with 10 teeth sharp and 10 teeth dull. The second was ground with two teeth of zero rake angle, followed by two of 5-degree negative rake, two of 10-degree negative, and two of 15 degrees, the remaining teeth being ground with 5, 10, and 15-degree positive rake angles.

In the planing operations photographed, several different materials were cut, with forged high-speed steel tools, one inch by 1½ inch by eight inches long. 18-4-1 high-speed steel tools were used to cut steel, yellow brass, and cast iron, operating at 37 surface feet per minute, the depth of cut being .040 inches; these tools were further photographed cutting, at 60 surface feet per minute, two pieces of steel of different hardnesses, which were clamped end to end on the planer so that one cut followed the other. Carboloy tools were then photographed in use on the planer, cutting these same two materials at 160 surface feet per minute.

With the aid of the 1/32-inch horizontal and vertical lines marked on the workpieces photographed, plus the camera's built-in timing dials, it was possible to plot true time-distance graphs for the alternate forward motion and retarding of the teeth of a cutting tool in action. This was done by projecting the developed pictures, one at a time, on paper marked off in large squares, moving the projection machine until the small squares in the pictures were superimposed on the large squares on the paper. Thus graphs could be drawn to scale, the sides of the large squares corresponding to the 1/32-inch sides of the squares marked on the workpieces.

From these time-distance graphs — together with viewing of the film projected as a motion picture, and study by photomicrography of the structure of the chips and the completed machined pieces — have been learned facts that may be of inestimable value in the constructing of future machine tools; in the designing of the "machine" and the grinding of the "tool."

Through the use of high-speed photography, for example, can be determined the maximum speed at which a given machine tool can be operated without danger of erratic operation, caused by inertia of material being cut or too great deflection of cutting teeth — without danger of distorting the material being cut to such an extent as to render the material unsuited for the application in which it will be used.

Photographs have shown, among other things, that material ahead of the tool is distorted in the direction of the tool's movement, causing distortion not only of the chips cut away, but of material below the line of the cut. They have shown that compression on and consequent deflection of a tooth, as it builds up power to begin the cut, is much greater at the beginning of the cut taken than when the end of the cut is neared, due to the larger amount of material ahead of the tool in the beginning. They have shown that the speed of the tool is directly related to such compression and deflection.

Maximum speed without danger of deterioration, due to heating, of the tool's cutting edge can also be determined. Perhaps most important of all, where speed is concerned, is the fact that the maximum speed possible with minimum regrinding of tools can be accurately fixed, resulting in the highest possible efficiency of a given tool; that is, the highest possible number of cubic inches of material removed, the greatest number of finished pieces turned out, in the least possible time, with the minimum number of tools.

Causes of chatter — that is, the wind-up in the arbor when heavy deflection occurs, and the irregular feeding of tables — can be studied, and in many cases might be remedied by improving smoothness of feed and by operating at slightly lower speeds, thus reducing vibration and lengthening the life of the machine as a whole.

The most efficient rake and clearance angles to provide the largest amount of material cut

away at the greatest speeds may be determined. By improving rake and clearance angles, not only might it be possible to produce a more accurate machined surface, with less slipping and greater smoothness of action; it might also be possible to control the action of the chip, with the purpose of lessening its abrasive or "cratering" action on the face of the tool, thus lengthening tool life.

It can be learned, through photographing teeth of different degrees of sharpness, the length of time the tool can be efficiently used before regrinding, as well as just which coolant is most effective, on a given type of cut in a given material, in reducing abrasive and welding action between chip and tool face and in reducing the built-up edge of material which accumulates on the cutting edges of the tool and appreciably slows up its action.

With the information gained through studies made by means of high-speed photography, when such studies have been made in sufficient number, it is believed that changes can be made in the designs of various types of machine tools which will make it possible to obtain from these tools maximum efficiency and the speed so vital, during these times, to American industry.

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Glass Blocks Bend Light

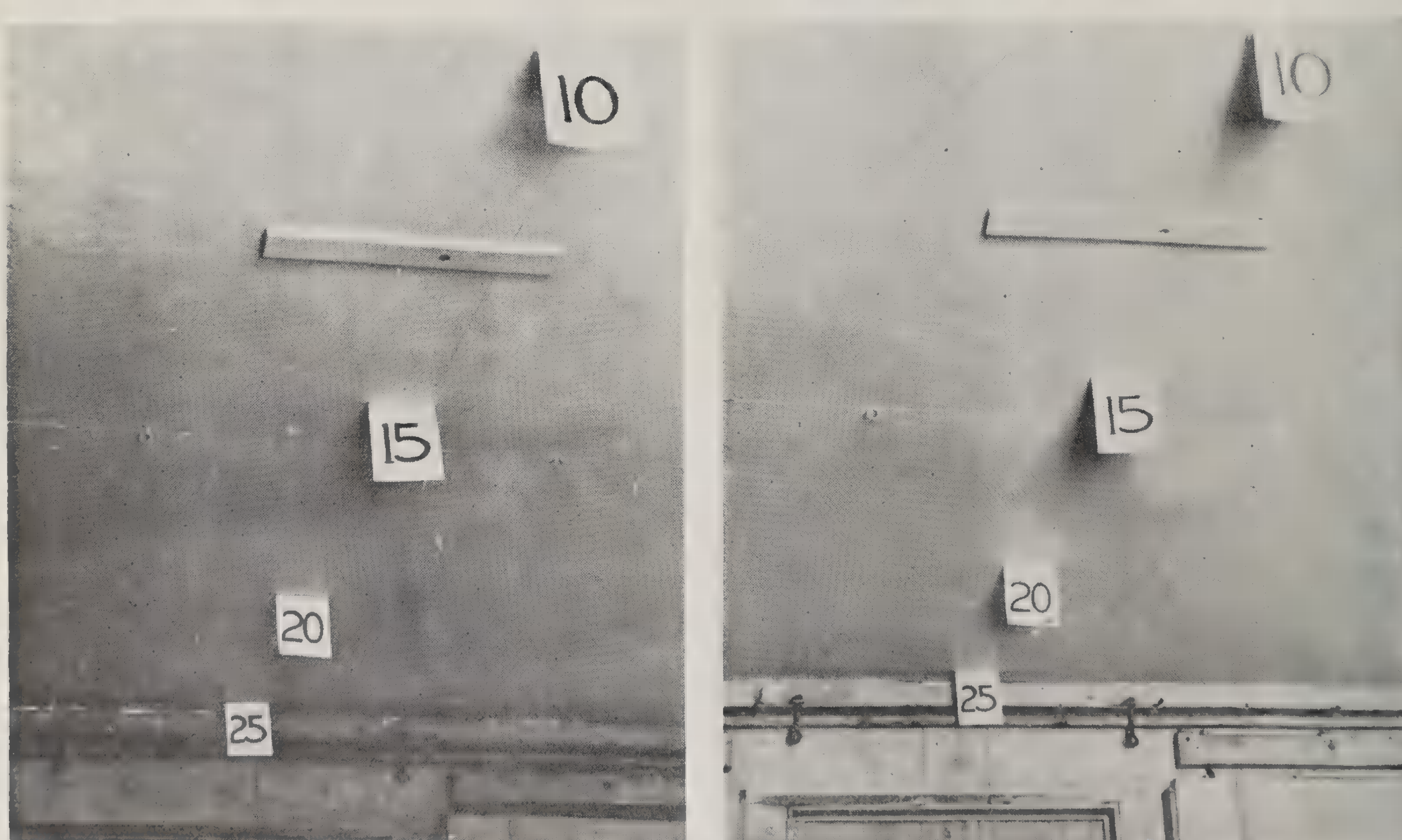
Daylight Conservation Achieved by Refraction of Incoming Light to Ceilings and Sidewalls

THE current national emergency and its speeding up of industry has caused a drain on the nation's power resources, especially in the east and southeast. Hence lighting engineers, in an effort to conserve as much *daylight* as possible, have been experimenting with different means of providing maximum useful daylight for interior illumination of office buildings and industrial plants. The most successful test reported to date involved panels of Insulux glass blocks, which, used in place of windows, provided more usable daylight, more evenly distributed.

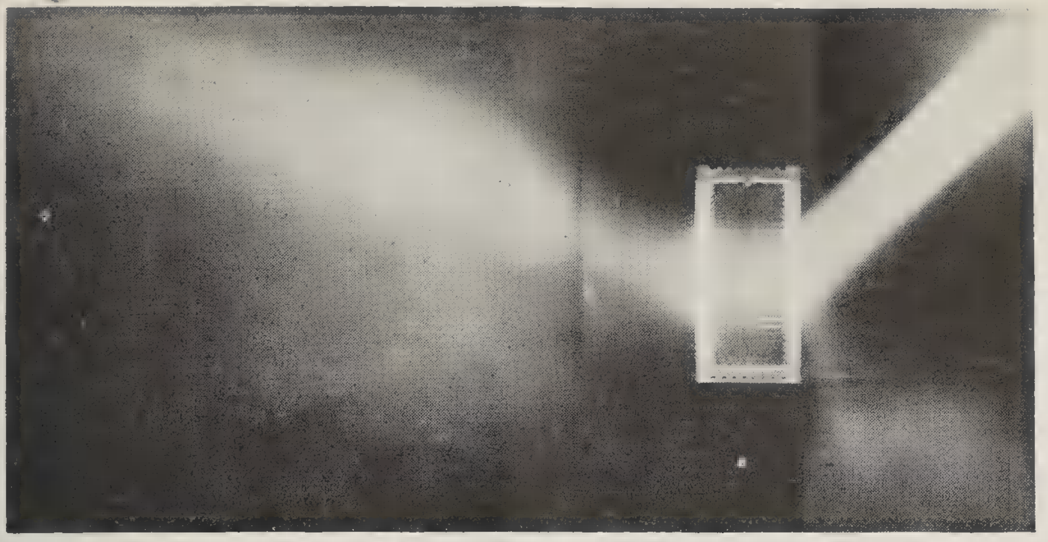
These blocks, which incorporate interior prismatic sections, serve to bend or redirect light rays, so that instead of falling in a direct line downward toward the ordinarily dark floor, the rays are turned upward toward the ceiling and upper walls. These surfaces, in turn, reflect the light down and toward the interior. This system of daylighting was developed by the Insulux Division of the Owens-Illinois Glass Company. It is claimed that no system of louvers, reflectors, or baffles now in use equals it for all-around efficient use of daylight indoors.

THE engineers working on the lighting tests used an ordinary room with dimensions of 23 by 25 feet with a single unglazed opening in an exterior wall. Immediately after pictures were made of the room in that condition a panel of Insulux glass blocks was installed in the opening and other photos taken. All of the photos were made with the same camera on the same film, under brilliant sunlight conditions, with identical exposures. Prints were given the same exposure by the printer and were not retouched.

The results were striking. The pictures taken of the room with



Left: **Light from unglazed opening compared with** *(right)* **light through new glass block**



Section of glass block, showing how light rays are refracted

the unglazed opening show a poor and inadequate diffusion of light, the dark floor having absorbed much of the direct light which streamed in through the opening. When the glass-block panel was installed, the light striking the outside of the panel was redirected upward toward the ceiling and diffused deep into the interior due to the prismatic design of the blocks. Instead of falling, then, on the dark, highly light-absorptive floor, most of the light was directed at the upper half of the room. These surfaces reflected it downward to the working levels.

The fact that the prismatic blocks are translucent insures complete privacy at all times, an essential to many defense plants. Besides redirecting daylight efficiently, they serve as insulation against all types of weather; because of their insulating qualities they retain within the structure much of the cooling temperatures achieved with air-conditioning units.

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SAFE AT WORK

Better Lighting Reduces Industrial Hazards

America's 6,000,000 men and women industrial workers handling complicated machinery and entrusted with the task of producing the nation's weapons for defense at an accelerated tempo, are safer from injury at work than at home or in automobiles.

This is true primarily because of the development by research of new light sources such as fluorescent and mercury vapor lamps now widely used in factories, according to Oscar P. Cleaver, well-known Westinghouse lighting engineer. United States defense industries, says Mr. Cleaver, now use two to five times more light than ever before over workbenches and production aisles to speed output and minimize possibilities of accidents involving workers.

"Industrial leaders realize," he declared, "that more light flooding work areas increases efficiency and cuts down injuries at a time when production must not be disturbed. We cannot afford to lose workers. While we can replace machines, we cannot easily replace highly skilled employees."

Latest available statistics compiled by the National Safety Council, Mr. Cleaver disclosed, report that more than twice as many fatal accidents occur in motor vehicles as in occupational pursuits, and approximately twice as many occur in homes as in industry.

"In recent years," he said, "surveys show that light in factories throughout the nation has been rated at an average of about 10 footcandles, as compared with ideal light in the shade of a tree of approximately 1000 footcandles.

"Under these conditions, statistics reveal that about 140,000 injuries could be expected among 6,000,000 workers in a year. Of this number, one out of four, or 35,000 of the anticipated injuries would result in permanent loss of vision."

This situation is changing for the better, the engineer said. In many defense plants, lighting intensities are now often maintained at averages varying from 30 to 50 footcandles. For close work as many as 100 footcandles are supplied the worker.

"Until research laboratories successfully developed fluorescent and mercury vapor lamps," Mr. Cleaver explained, "it had not been practical nor possible to raise lighting levels in industry. The fluorescent lamp, however, is cool, is approximately twice as efficient as an incandescent, supplies glareless light, and is economical to operate when burned long periods of time. Mercury vapor lamps have also become an important source for an abundance of light under certain conditions."

More than 10,000,000 fluorescent lamps were in use in this country early in 1941; during that year the lighting industry estimates that an additional 20,000,000 were put into service.

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LIGHT: Approximately 156,000 fluorescent lamps are being used in the world's largest installation of these tubular light sources. They are being placed in the $47,000,000 Ford bomber plant near Ypsilanti.

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TWO LAYERS

Of Plated Metals to Replace Galvanizing

Drastic curtailment in the metal-coating industry has stimulated interest in the new Corronizing process, which is claimed to reduce by 50 to over 90 percent the necessary tonnages of zinc and tin used for galvanizing and tinning ferrous and non-ferrous metals.

Corronized coatings, already in use by several licensed manufacturers for various sheet, strip, and wire products, consist of several exceptionally thin layers of metal and alloys, having unusual corrosion-resistant properties. The coatings are formed by electroplating a thin layer of nickel on the base metal, followed by a layer of either zinc or tin much thinner than ordinarily used for equivalent galvanized or tinned coatings. Conventional electroplating equipment and standard plating solutions can be utilized with only minor changes, the novel features of the process arising from the technique of application and subsequent treatment. After the two metallic layers have been plated on, the coating is baked at a fairly high temperature (500 to 750 degrees, Fahrenheit) for up to one

hour, during which time the two metals mutually diffuse to form new layers of alloys of different composition. The resultant coating not only is highly resistant to corrosion in salt spray, humidity, and normal atmosphere tests, but it is reported that it can be twisted, bent, molded, soldered, and even welded satisfactorily.

Applications of Corronizing now in production by several manufacturers include insecticide spray tanks, wire screening, copper oven thermostats, and outboard motor parts, while tests have been made on other products such as welded wire fences, pump rods, oil cans, springs of surgical appliances, metal stampings, and formed parts.

A main present disadvantage of Corronizing is its use of nickel, even though only a small quantity of nickel is required to save much larger amounts of zinc or tin.

While atmospheric exposure tests are not yet completed, preliminary indications are that the superiority predicted by accelerated tests will be fulfilled in actual use. It is further claimed that the coating has some tendency to self-heal when failure occurs, thus slowing up complete deterioration, while ordinary galvanized coatings fail after part of the coating has been corroded away.

Because of the reduced quantities of metals necessary for a given quality of protection, Corronized coatings are now said to compete in cost with hot-dipped and electroplated zinc coats in the lower-quality field, though its possibilities have not been definitely established for higher-quality applications of various kinds.—*The Industrial Bulletin* of Arthur D. Little, Inc.

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ERASERS—Plastic eraser holders on pencils, in which one pound of plastic replaces about two pounds of metal, released an estimated 150,000 pounds of metal to vital industries during 1941.

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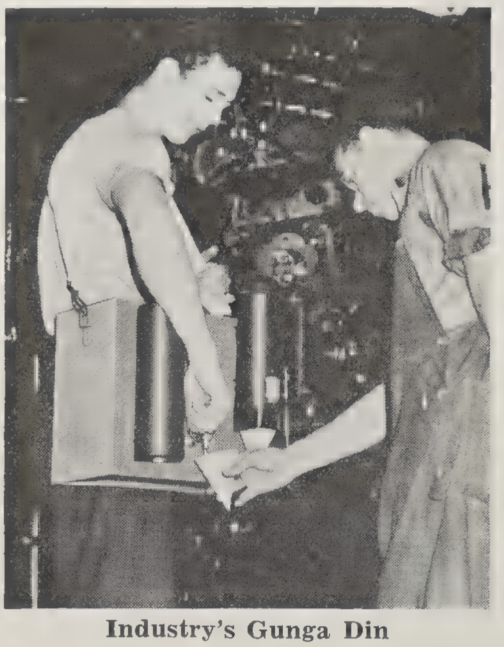
GUNGA DIN

Now Plays His Role in Modern Industry

For dispensing water in a sanitary manner, on defense construction jobs and in factories, a new mobile water tank unit has been developed by Universal Paper Products Company. These units eliminate the dangerous "germ-exchange" bucket and dipper method of dispensing water—a method which is actually prohibited in all but three states, but which has crept back into practice unnoticed, in the drive for increased defense production.

In tests it was found that the new water tanks are definite time-savers. Where workers were spending from 5 to 10 minutes going to and returning from stationary drinking-water dispensers, these mobile units eliminate the valuable waste time.



Industry's Gunga Din

Tanks are made in two models. One can be carried on the back, and the other at the carrier's side. Both are made from lightweight metals and have adjustable shoulder straps, a paper cup dispenser, and standard faucet. A large mouth allows quick filling and easy cleaning. Both models can be had with a sturdy canvas jacket that has a hair-felt lining which serves as both insulation against hot and cold, and as a padding for the carrier's comfort.

MORE WORK

From Existing Tools to Increase Production

In a single airplane engine there are often 900 different parts; counting duplicate parts, a total of more than 8000 pieces of metal. And with the exception of the rocker arms, every fraction of every square inch of these pieces must be machined. In producing a single 75mm shell and fuse there are more than 100 separate machine operations. There are 3390 separate machine operations on the parts of a .50-caliber machine gun. Production of an aircraft engine may involve as high as 45,000 separate operations on machine tools.

These illustrations are typical of the defense program as a whole. The volume of machine tool work in defense industries is enormous. Expanding machine tool output is a very different proposition from expanding output of a single article, such as a lawn mower.

In size, machine tools range all the way from that of a sewing machine to that of a two-story house. In cost, they range from less than \$50 to over \$50,000. Machine tools must be designed to do the particular job for which they are to be used.

Therefore the machine tool industry could not use the principles of mass production. Machine tools, on the whole, have to be built to order, and this takes time.

If every machine tool operator of this country would step up his output by 10 percent, the result in increased performance would be the equivalent of a whole year's production of new machine tools.

Of course, we can attack the situation from a more wasteful point of view. We can build dozens of new plants, train thousands of new men, sub-contract more extensively. But all this takes more money, and what is still more important, it takes more time. Certainly it would seem vital at this particular juncture to make an "all-out" effort to get maximum productivity out of existing machine tools. With that behind us, we would then be in a position to know concretely how many more machine tools, how many more new plants, and how many more new men would really be required. —*Charles J. Stillwell, president of the Warner & Swasey Company, in* The Clevelander.

HARDENED STEEL

New Process Recalls Fame of Damascus Blades

A new method of hardening the surface of steel by the use of synthetic urea was described recently by Ray P. Dunn, research metallurgist of the Electro Manganese Corporation; W. B. F. Mackay, flying officer, Royal Canadian Air

Force; and Prof. Ralph L. Dowdell, professor of metallography, University of Minnesota.

The use of synthetic urea as a source of nitrogen in the "nitriding" of steel was investigated because it is cheap, easy to handle, can be obtained in commercially pure crystals, and gives off ammonia gas, a compound of nitrogen and hydrogen, when heated to 270 degrees, Fahrenheit.

This process brings to mind the famous Damascus blade of medieval times, which is said to have been surface-hardened by the use of camel's dung. If so, these early artificers were unwittingly applying a crude form of the modern process of nitriding steel.

The present investigators tested their process on small specimens of three types of steel, using different furnace temperatures to ascertain the best conditions. Hardness tests on the nitrided specimens showed that high commercial hardness can be obtained with the urea method and the conclusion was drawn that the method has distinct commercial possibilities.

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REFLECTORS: Silvered glass reflectors are being used to replace highly polished aluminum reflectors in the pendent type street light manufactured by one large electric company.

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RESEARCH MILLIONS

New Record Set For Expenditures

Breaking their own records for spending millions to develop new American-made products, manufacturing industries throughout the country invested $117,490,000 into research during 1941 for America's future.

Contrary to the wide belief that big companies do all the research work, little and medium-sized companies spend relatively as much as big companies on experiments and tests and inventing, Robert I. Lund, chairman of the National Association of Manufacturers' committee on patents and research, reports as the result of a study of 1008 firms, conducted by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology.

Only 8 percent of the companies reporting research outlay said that they are spending less than in 1940, while 43 percent said they are spending the same as in 1940, and 49 percent are spending more. Companies with research programs averaged more than $116,000 per company last year.

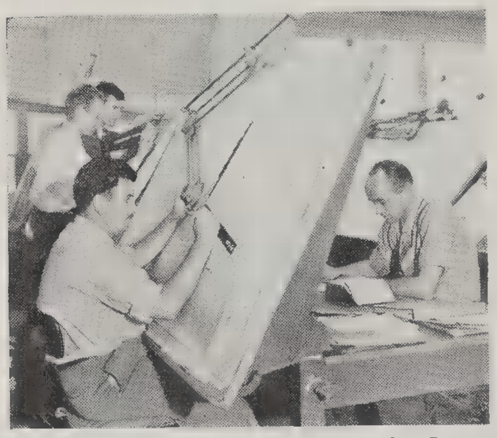
"Here is tangible evidence of industry's faith in America's future," declared Mr. Lund. "In industrial research lies the great hope for reemployment, for productive application of savings, and for the beneficial utilization of war production plants."—*Science Service.*

DRAFTING BOARD

Cranks Up and Down, Provides Comfort

An engineering drafting board which cranks up and down is a new development of the engineering department of The Glenn L. Martin Company. Taking a load off the feet and stomachs of the men who have spent most of their lives standing or leaning over tables, the new board now seats them comfortably in swivel chairs.

When not being used, the board lies flat on its desk-top. The draftsman, seated in his chair, twirls a small window-type crank which raises the board to the desired level. Then, by means of a horizontal bar, beneath the edge of the board, he adjusts it to the proper angle. The board is kept in firm position by a "dog," controlled by the bar, which drops into a notched locking sector. These tables are set in parallel rows so that the draftsman uses his own adjustable table for drawing and with but a half-turn of his chair has immediate use of the desk half of the combination table behind him.



Less clean-up time required

Draftsmen, who for many years endured the strain of being on their feet all day at the old tables, like the new invention and contend that they accomplish a considerably greater amount of work and with noticeably less fatigue at the end of a long day.

Another advantage of this tilted drawing surface is the greatly diminished amount of soiling due to perspiration and the rubbing in of pencil dust, as the draftsman stretches and reaches across his work. This in itself is quite a time-saving factor as finished work requires less cleaning-up.

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NAILS—Five tons of nails—100 kegs weighing 100 pounds each—are used every day at the Windsor plant of the Ford Motor Company of Canada in crating military vehicles for shipment to the British armies overseas.

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REFRIGERATION

Has Many Uses, Even in Defense

Of course refrigeration will keep vegetables and meats from spoiling and occasionally give you the shivers when you enter a really air conditioned room on a hot day. But what about these less usual cases. Iced cookies are kept firm, do not stick together. Coffee is kept fresh. Bread and pastry are kept from molding. Sugar and salt kept in the refrigerator do not get lumpy. Cigars are kept in good condition. Cosmetics do not get soft and oily. Medicinals such as cod-liver oil and mineral oil if well chilled show a reduction of odor and taste intensity and are more palatable. Even a young lady reports that her angora sweater does not rub off on her boy-friend if put in the refrigerator for a couple of hours before wearing.

Refrigeration even has its place in the defense program, and not only to chill soft drinks and provide ice cubes for more authoritative beverages. Mercury fulminate is the detonator which sets off the charge of powder in a cartridge and of other explosives in shells. As one may imagine from that use it explodes pretty readily and isn't manufactured in the center of any of our large cities.

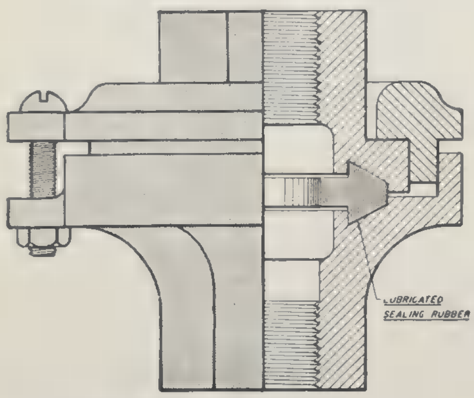
An explosion is a chemical reaction, therefore is slowed down with decrease in temperature, gen-

erally lessened in rate by one-half for every decline in temperature of 10 degrees, Centigrade. So mercury fulminate is stored in refrigerators until ready to be used, as a means of increasing safety in handling it.—*The Chemical Digest.*

LEAD LUBRICANT

Combined In A Rubber Gasket

THE lubricating qualities of lead are serving a useful purpose in a new type of swing joint for low-



Powdered lead in rubber gasket

pressure steam lines developed by the Patterson-Ballagh Corporation. The secret of the efficiency of the joint lies in a rubber gasket, into which powdered lead is milled before the gasket is shaped.

Because of the lubricating action of the lead, it is claimed that the new joint turns more freely under pressure than other types and that the lead lengthens the life of the gasket.

As the cross sectional drawing herewith indicates, the lead-rubber gasket is specially shaped to insure a tight seal and at the same time provide flexibility to the joint.

The swing joint, which handles steam pressures up to 100 pounds, is designed for use on moving machines or equipment which are connected to stationary steam lines. Typical applications are steam lines on rubber molding and chemical equipment.

AND NOW SHELLS

A Long Step From Automatic Pencils

MASS production methods, as developed by American industry, are being effectively applied to the manufacture of war materials for the national defense program in hundreds of factories, large and small. Most of these plants had been making articles for peacetime consumption. Now they have converted many of their machines and tools for the production of instruments of war.

An interesting example is the case of Paul Hauton, consulting engineer, who gathered a group of young engineers, 18 years ago, and organized the Scripto Manufacturing Company in Atlanta, Georgia, which today produces from 13 to 15 million automatic pencils a year. These pencils are sold throughout the world for ten cents or the equivalent.

When the national defense program got under way, Scripto was given an order to make two million brass boosters for artillery shells. Engineers estimated that by working 24 hours a day, 1000 men could produce 10,000 boosters a week at a cost of from $1.75 to $2.50 each. After months of designing gages, making tools, and building machinery, Scripto was ready to begin production. With just 150 workers Scripto turned out tens of thousands of boosters a week, and they only cost the Army 55 to 75 cents each.

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TRUCKS: One out of every twenty trucks operating on the highways of United States is owned and operated by local, state, or federal government units.

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HIGH GLOSS

Liquid Plastic Used in Printing Process

A HIGH-GLOSS surface applied over any type of printed matter on heavy paper or cardboard, and which is designed to replace present varnishing and other methods, is simply achieved with a machine which applies a molten coating of plastics either over the printing for enhancement or as a protective interior coating.

The plastic material used is reduced to liquid form by heat, there being no solvents or liquid carrier used. Hardening of the film is obtained by chilling alone, eliminating any drying or racking; the piece is finished when it leaves the machine.

The plastic is put into a heated tank or reservoir, from which it is picked up by an application roll, which in turn is doctored to give the proper coverage. A pressure roller is adjusted by adjustment screws and from this point the piece is carried between polishing rolls which are adjustable for the weight and character of the sheet. All heated parts are thermostatically controlled to operate at varying temperatures, depending upon the coating material used.

The chemicals used in the process, developed by Bert C. Miller, Inc., are specially formulated materials to give the desired characteristics to the particular job. For example, where an extremely high gloss is desired, with full flexibility at the folds, one material is used; should a very high degree of greaseproofness be desired, another material may be used. The range of materials is quite wide and designed to cover most any requirement.

Over-printing with plastic

When box blanks are coated they may then go directly to the gluing machine, but special glues for holding on waterproof surfaces are necessary.

WELDING

Experiments Shed Light on Effect of Rod Temper

"RESULTS of extensive welding experiments with rods of nickel, Monel, and Inconel, in which the nature of the wire was varied from the soft, fully annealed to cold drawn hard tempered condition, proved that the condition of temper of the core wire had no effect on the resulting weld." This statement was made by F. G. Flocke and K. M. Spicer, welding technicians of the International Nickel Company, in a paper entitled, "A Study of the Effect of Core Wire Temper on the Quality of Welds in Nickel, Monel, and Inconel," presented before the Annual Meeting of the American Welding Society.

INDUSTRIAL TRENDS

MOLYBDENUM LOOKS UP

TUNGSTEN, nickel, vanadium, chromium, and molybdenum are five elements that hold places of importance in the steel industry; they are used in varying proportions in steel alloys to produce resulting metals that have characteristics which fit a wide variety of purposes. Yet of these five elements, molybdenum holds a unique advantage over the other four. It is the only one of the five that is currently produced in sufficiently large quantities in the United States to meet present needs. In the case of the other four, relatively large quantities must be imported to supplement our own supplies. And, at the time of writing, it appears that at least two of these needed alloying metals will be available in even smaller quantities than in the recent past; much of our chromium comes from the Philippines and of our tungsten from China.

The properties which molybdenum impart to alloy steels include an increase in the elastic limit of the metal and in resistance to impact and other stresses. "Moly," as the element is frequently called, is also used in the manufacture of stainless steels.

Molybdenum may be used alone in producing high-strength steel alloys or in conjunction with one or more other alloying metals. Now, in view of the decreasing supplies of some of the other ingredients of alloys, and even complete unavailability in some cases, it is no matter of wonder that increased attention is being given to research directed along the lines of finding the best ways of getting the most advantageous results with this relatively plentiful element. It is no secret that these researches are successful in many respects and that new uses being found for moly will find permanent places in industry. When the world returns to normal, and other steel alloying elements once more become available, they will find moly well up on top of the pile, doing jobs that they used to do and in many cases doing them just as well and just as economically or better and cheaper.

CORK FACES TROUBLE

DESPITE continuing endeavors to grow satisfactory cork trees in the United States, particularly in southern California, the supply of commercial cork still comes from countries bordering the western Mediterranean. It is thus obvious that those industries in the United States which require cork for any purpose are facing a production problem of no small moment.

Of the 150,000 tons of cork normally consumed each year in this country, some 70 percent goes for insulation purposes, 16 percent to crown corks and gaskets, 8 percent to linoleum, and the remainder to life preservers and other cork products including solid corks for bottles, according to *Barron's*.

Let's get some of these uses down on their backs and examine them in the light of possible alternate materials, thus getting a view of the possible trends which must result if our cork supply is cut off or even drastically reduced.

Insulation: The tiny air cells in cork give the material its outstanding insulation properties. But glass wool, rock (mineral) wool, and many wood and other vegetable fibers have similar properties and can be produced in large quantities.

Crown corks and gaskets: These two products use cork in thin sheet form. Several forms of synthetic rubber are possible alternates in these fields, as are also other substitutes, all of which have the disadvantage of higher cost, but the advantage of availability. Gaskets, used in internal combustion engines, stand the best chance of continuing to be made of cork as long as any of the material is available.

Linoleum: Very little cork is used in present-day linoleum, except in the heavy-duty types. Advances in the linoleum industry have produced many satisfactory substitutes long before the exigencies of war made them necessary. Thus there is already a foundation for production of all needed linoleum without cork.

Life preservers: Balsa wood and kapok are logical substitutes as long as they can be obtained. Then there is the inflatable type, already in wide use, which depends on carbon dioxide to furnish flotation.

Solid corks: Many whiskey, wine, and other liquid containers are now being sealed with metal and composition screw caps using inserts similar to those in crown caps, placing this problem in the same category with crowns, if and when the cork shortage forces all bottlers to turn to this type of closure.

All in all, it does not seem that the cork situation is so serious that it cannot be met by ingenuity, although it will undoubtedly mean serious and expensive readjustment throughout the industry.

WHAT ABOUT THE WAR?

WHEN "Industrial Trends" was first inaugurated as a feature in Scientific American, its purpose, which is still being pursued, was to acquaint readers with those phases of the progress of science and industry which, because of their partly speculative nature, could not always be treated by the straight reporting technique which pertains in the rest of the magazine.

Now we have come to an important crisis in world events. At the time of writing, the flames of war have scorched American possessions, continental United States is rapidly preparing to face possible invasion, every effort has been turned toward production of those military and naval materials that are essential to the protection of our country and the successful waging of war against aggression.

Still the trends of industry remain of outstanding importance. Higher production speeds are being gained in many lines; new and better methods are being developed under the pressure of necessity. And out of the lessons that industry is learning are coming the trends of peace-time production—new materials, improved processes, industries based on products heretofore unknown.

More than ever, then, it is essential to keep an eye on the rapidly changing picture of industry if trends are to be projected into the future when human beings turn from Mars to Mother Earth and once more take up their normal lives.

—*The Editors*

Stellar Advertising Signs

Neon, So Rare on Earth, Proves to be 1000 Times More Abundant in the Stars

HENRY NORRIS RUSSELL, Ph.D
Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE average citizen knows more about chemistry than did his predecessor 50 years ago — at least about the names of things and some of their properties. In those days chromium was known to most folks, if at all, as a constituent of certain paints. Now its appearance is so familiar that we talk of the "chromium-plated" type of architecture. But a little longer ago, aluminum was a costly curiosity — now it is even more important in defense than in the household.

A list of all the elements which have passed from the unfamiliar to the familiar would be fairly long. Some of them, like the two just mentioned, occur in great quantities, and owe their changed economic status to the development of practical methods for producing and utilizing them. Others, like tungsten, are rare but have found important technical applications. Should we ask what is the rarest element which is now utilized in a manner familiar to everyone, the answer must, of course, be radium — whose use in luminous paint depends on its most distinctive property. Next to this comes neon, which is unique in being commercially valuable solely for its spectroscopic properties. Like all other gases, it can be set shining by a high-tension discharge; but no other gives off light of such esthetic appeal.

Argon has a spectrum exactly like neon in structure — they can be matched line for line — but the argon lines corresponding to the great group of neon lines in the red are in the infra-red, or so near it that they are hardly visible, so that an argon tube shines with a feeble purplish light (compounded from fainter lines in various parts of the visible spectrum) and has no advertising value.

Neon forms 1/55,000 part by volume, or 1/77,000 by weight, of the atmosphere, which itself has only a millionth part of the weight of the whole earth. It was formerly supposed that neon, which does not combine chemically, must be absent from the body of the earth; but Lord Rayleigh, after a very careful investigation, found that igneous rocks contain, on the average, one cubic centimeter of neon in 12 tons, or one part in 14 billions by weight.

These are, of course, surface rocks. No one knows whether the deeper rocky part of the earth contains the same proportion. If it does, the whole amount of neon trapped in the solid body of our planet comes out four times that present in the atmosphere. On this admittedly uncertain basis, it appears that neon accounts for only about one ten-billionth part by weight of the whole earth.

IN THE atmosphere, argon is 520 times more abundant than neon by volume, and very nearly 1000 times by weight. Rayleigh finds about 500 times more argon than neon in the rocks.

Most of the elements which we call "rare" are far more abundant on earth than neon. In the surface rocks (which alone can be analyzed), there is one part in ten millions of silver and one in 200 millions of gold or platinum. The rarest of the "rare earths" are more abundant than silver.

If neon was as rare in the heavens as on earth, we could not expect to find perceptible traces of its lines in any spectra — but in some cases they are conspicuous. Lines of neutral neon — the very ones which make neon signs so conspicuous — appear in absorption in the spectrum of stars like Rigel, and lines of ionized neon in hotter stars. The gaseous nebulae, too, show neon lines in their spectra (forbidden lines, as in the case of other elements). Some lines of argon have been observed, both in stars and nebulae, but these are fainter, indicating that the relative abundance of the two gases is reversed.

From measures of the widths of the absorption lines in good stellar spectra, the relative abundance of the elements which produce them can be determined. An attack upon this problem was made just before the war by Unsöld, a first-rate German astrophysicist, using spectra taken for the purpose at the McDonald Observatory in Texas. The hot star, Tau Scorpii (next to Antares on the left), proved especially well adapted for this study, as its spectrum is full of sharp lines. A few copies of the resulting paper have reached America. The methods of calculation, some of which are new and very ingenious, need not be described here; but the results are of great interest.

LINES of only a few metals were observable, but these are among the most abundant in the Sun and the cooler stars, and afford a connection with our previous knowledge. Magnesium and silicon are about equally abundant (as in the Sun) and ten times more so than aluminum. Taking these two as a standard, the amount of carbon, by weight, is approximately 1½, of nitrogen 3, of oxygen 10, and of neon 15. Neon is the most abundant element (whether by weight or number of atoms) except for the lightest of all — the amount of hydrogen by weight being 600, and of helium 450.

The enormous abundance of hydrogen has long been known, and that of helium anticipated — though these are the first numerical data. But the high abundance of neon was unexpected. The evidence in its favor is fully convincing, and any surprise at it is only one more indication how much our terrestrial experience subconsciously influences our thinking.

It will be of great interest to test the relative abundance of neon and oxygen in other stars which show the lines of both, and this will doubtless be done before long. But it is highly improbable that the conclusion that neon is among the most abundant of all the elements after the first two will be upset. We need not worry about the Sun, for a simple calculation shows that, at its low temperature, even the strongest neon lines

(being absorbed only by highly excited atoms) would not show unless it was very much more abundant than oxygen.

But the extreme rarity of neon on earth urgently demands some explanation. There is at least a billion times more oxygen than neon on our planet. How could such a tremendous difference have arisen?

The answer is not really far to seek. The relative proportions of the heavier elements, from sodium onward, are nearly the same in the Earth and the Sun. In several cases, when previous estimates of the abundance in one or the other have been corrected on the basis of better evidence, the agreement has been improved. In other words, the relative proportions of all those elements which form compounds that are solid or liquid at the temperature of molten rock are nearly the same, while those elements whose compounds are gaseous at such a temperature are much less abundant on the earth.

This is exactly what might be expected if the material which now forms our planet had condensed out of a cooling, but still hot, gaseous mixture similar in composition to the Sun or the stars. Just as rain drops or snow flakes form in moist, cooling air — although water-vapor forms but a small percentage of the whole — compounds of high melting and boiling points would condense out of the gas. With hydrogen present in large excess, the more easily reducible metals, including iron, would separate out wholly or partly in metallic form. Difficultly reducible metals — magnesium, aluminum, calcium, sodium, and also silicon — would combine with oxygen, and condense into a silicate magma. Large quantities of oxygen would thus enter the melt, and smaller quantities of carbon, or even of nitrogen, might be included; but helium, neon, and argon could at best be dissolved by it, probably in very small amounts, and the great excess of hydrogen would remain free.

SPITZER'S investigations (reported on in these columns in March, 1940) show that such condensation would not occur in a "filament" of matter stripped off by the collision of two stars; but they do not prove that condensed droplets, or large masses, could never be formed under any circumstances. The composition of our planet affords the best reason for supposing that, at some time and in some way, it *was* so formed.

OUR planet is now surrounded by vast empty spaces, hence it must have escaped from the gas-cloud which is here postulated. When it began an independent existence, it was presumably very hot even at the surface. It may have carried with it some of the lighter permanent gases; but hydrogen and helium would rapidly escape and, if it was hot enough, neon would escape too, and also water-vapor and nitrogen, so far as the N_2 molecule was dissociated into atoms. The probable later history is familiar. The dense metal sank to the center, where it still forms a liquid core. The silicate mantle, 1800 miles thick, gradually solidified, beginning at the bottom, where the pressure raised the melting-point. As it froze, great quantities of water-vapor and other gases were released, which rose to the surface — now not hot enough to admit of the escape of these gases against gravity — and formed a great atmosphere, mostly of steam. When the surface grew cool enough, the water of the oceans condensed, leaving a permanent atmosphere.

The great 80-inch telescope at McDonald Observatory, where the work described was done

The oxygen in our present atmosphere may be accounted for by decomposition of carbon dioxide by plants since life began. The nitrogen, neon, and argon must have been there before the oceans condensed. Whether they were there before the great lava-mantle froze is uncertain.

Rayleigh, in the work mentioned above, found that there is a small, but easily measurable, amount of nitrogen in ordinary rocks, amounting to about 1/200 of one percent by weight. On this basis, the rocky mantle still contains 50 times as much nitrogen as the atmosphere.

The nitrogen in the rocks is, at least in part, chemically combined, and is converted into ammonia by heating with alkali. This important discovery makes it entirely possible that the nitrogen of the atmosphere is not primitive, but was liberated by physico-chemical processes during the solidification of the rocks.

Oxygen accounts for nearly half the weight of the rocks, and is about 10,000 times more abundant than the nitrogen — while in the stars the difference is the other way. This difference may be taken as a measure of the average relative affinity (to use an old word) of the rock-forming metals for the two elements.

Similar reasoning about neon and argon would have to start with some assumption how they got into the rocks. At present, as Rayleigh suggests, they are probably trapped, an atom here and there, in the lattices of atoms composing the crystals. Whether they were previously dissolved in the molten silicates, and, if so, how much would have been set free on solidification, is a question on which the present writer has no data. Until more is known, it is hard to be sure that any constituent of the present atmosphere consists mainly of gas which was in the original atmosphere of the liquid planet.

ONE puzzle still remains. Lines of argon have been identified in the stars and the nebulae, but are weaker than those of neon, and it seems quite safe to conclude that argon is less abundant than neon, cosmically speaking. We must await measures of the intensity of the argon lines to find out how much less abundant it is. But it is clear that neon is at least a thousand times more abundant, compared with argon, in the stars than in the Earth's atmosphere. Rayleigh finds the same to be true for the gases in igneous rocks. Whether this means that the rocks got these gases in some way from the atmosphere, or that the original molten rocks in some strange way dissolved argon a thousand times more readily than neon, no one can say.

It is stimulating to have some things left for future discovery. — *Princeton University Observatory, December 5, 1941.*

Ancient Ostia

Ignoring Present-Day Strifes, Archeologists Unearth Rome's Once-Thriving Seaport

ALINE ABAECHERLI BOYCE
Fellow of the American Academy at Rome

FIFTEEN miles west and slightly south of the city of Rome lies the mouth of the River Tiber, where, according to legend, Aeneas, the founder of the Latin race, disembarked at the end of his long journey from Troy after the fall of that famous city. On this spot, it is said, was founded the ancient town of Ostia, in historical times the seaport of Rome. Archeological excavations, however, have indicated that the town actually goes back only to the 4th Century B.C., when Rome sent a military colony to garrison the site. Thereafter, Ostia became a distributing station for grain, and grew and thrived until, in imperial times, it was an emporium of 100,000 inhabitants, many of whom were foreigners from across the seas.

The excavations that have been going on there have revealed the town chiefly in its period of greatest prosperity—from the 2nd to the 4th Century A.D. The "dig" at Ostia is a project of tremendous importance to archeologists all over the world. Ostia has been undergoing scientific and systematic excavation since 1909, but has recently been uncovered on a large scale in sections previously almost untouched by the spade of the archeologist. For years the excavation has been under the direction of Professor Guido Calza, who has brought to light market buildings, apartment houses, shops, paintings, sculpture, mosaics, and inscriptions that equal, if they do not surpass, important finds of previous campaigns.

TO STATE the problem of excavation simply, we have at Ostia a city of the imperial period—that is, the middle of the 1st Century B.C. to the 4th Century A.D.—superimposed upon a city of the Roman republic (4th Century B.C. to 1st Century B.C.). The republican remains must be studied without destroying the younger and therefore higher imperial city, and the imperial city must be reconstructed safely and accurately.

Ostia, like Rome, suffered much in medieval and modern times from pillage for marbles and other materials, and parts of buildings and statues not previously carried off must be excavated and reconstructed with painstaking care. To quote Professor Calza: "In these works of restoration and reconstruction an attempt has been made to create the most complete picture possible of the ancient buildings, putting back the fragments found in excavating into their original places, which have previously been scientifically ascertained. . . This has also been done to some of the painted ceilings and mosaic floors fallen from above, which have been raised and replaced on their original level. . .

The elegant granary in Ostia

Sometimes, in order better to preserve the paintings, we have protected some of the rooms either by restoring the original vaulted roof or by making a wooden covering."*

The buildings lie chiefly on either side of a main street, or *decumanus maximus*, which leads from the entrance of the excavations toward the lower reaches of the Tiber. On the bank of the Tiber, opposite Ostia, lies a cemetery of imperial times, which contains the tombs of artisans or engineers connected with the later artificial harbor of Porto—tombs which are striking because of the handsome brick design which adorns their facades. Between this cemetery and the river on the one hand, and the previously excavated parts of Ostia on the other, lie the newly excavated sections, which spread out from the main street in all directions. Within the last five years the size of the excavated portions of the city has doubled, and it is indeed a large town of imperial Rome that the archeologists now can look upon.

Like many cities in ancient Italy, Ostia was surrounded by a wall constructed of large blocks of tufa, a volcanic stone. Before the

The view from the top of the ancient theater (see the text)

*G. Calza, *Ostia, Historical Guide to the Monuments*, translated by R. Weeden-Cooke, Milano, 1926, pp. 77-8.

In the foreground are big storage jars and a garden, while in the background are the archeologists' excavations in the vicinity of the forum

city wall was built there was a small *castrum,* or fortification, which goes back to the earliest history of the settlement, probably the 4th Century B.C. The gates of the castrum and considerable portions of the city wall have been found, though most of the remains are below the ground level. Before passing the foundations of a city gate near the entrance to the excavations, one must walk along that section of the main street which is lined with tombs of various levels and types. There are republican tombs at a lower level, with imperial burials above them; there are *columbaria,* or dovecotes, which held cinerary urns, and there are sculptured sarcophagi indicating inhumation, or interment, burials. Here and there an inscription gives the name and trade or official position of the dead.

STREETS lined with tombs, just outside the city walls, are a common feature of ancient cities. The Via Appia, leading south from Rome, ancient Rome's first great military highway, is perhaps the most famous example of such a street, though other roads leading from Rome were lined with tombs. Similar streets exist in Pompeii, and tombs were found on the outskirts of Ostia, the best preserved being the brick-faced tombs on the "Sacred Island" across the Tiber.

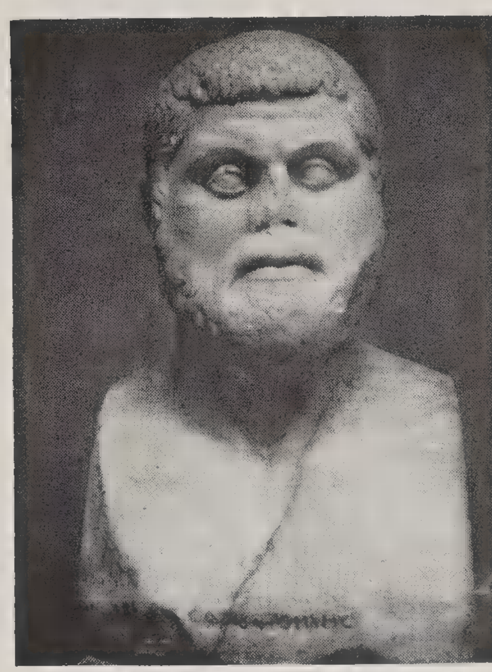
In the city proper, along the main street, which is crossed at intervals by minor streets, lie baths, warehouses, police barracks, temples, and a theater. From the top of this theater one obtains an excellent view of some of the excavations now in progress—a view shown in one of the illustrations. Beyond the theater lies a large rectangular open space, green with long, straggling grass, in the center of which stand the remains of a temple, consisting of the podium, stairway, and two columns of the porch. The remains of a colonnade surround the open space and behind the colonnade on three sides are traces of the offices of transport and merchant guilds from many towns of the Roman empire. The names of some of the guilds, together with the names of the towns and the symbols of the guilds which they represent, are still to be seen on the black and white mosaic floors of the offices. For the economic history of Rome these inscriptions in mosaic are of great interest. As one might expect, the rear of this enclosure lay close to the ancient course of the Tiber, which has since changed its direction.

On the main street, opposite the theater, are some of the new excavations of large public buildings, and on lesser streets are apartment houses and warehouses. One of the latter, shown in a photograph, is a granary, but it has a fine entrance and a handsome courtyard which anticipate in architectural style the palaces of the renaissance. In several storehouses, one of which has recently been excavated, and which also is illustrated here, can be seen immense earthen storage jars.

The apartment houses of Ostia are of interest because they, too, provide a precedent for renaissance and modern Roman houses, and because they are in direct contrast, moreover, to the suburban style of ancient house with leisurely atrium and peristyle, which is the dominant type in Pompeii. At Pompeii one occasionally finds a staircase leading up to a second story. At Ostia the apartment houses had several additional stories, and sometimes on the upper floors there were balconies reminding one of the balconies on apartment houses in the Rome of modern times.

FARTHER along the main street one begins to realize from the freshly uncovered appearance of the bricks that he has entered a newly excavated section—from here on all of the excavations are new. There appear two charming shops —a fish market with a marble table for wares, and a mosaic floor with fish outlined in black tesserae, or little black squares; and a second shop with a marble, rectangular basin surmounted by two thin, graceful columns. Of the shops throughout the old and new excavations, not the least interesting are the bars, or *thermopolia;* that is, "hot-drink shops." Some of the little wine-shops in Rome today bear a strong resemblance to these *thermopolia.*

One of the prettiest buildings in the new section has a dining room with marble-encrusted walls and a multi-colored marble floor, beautifully reconstructed from the ancient marbles found on the spot. This room is entered from a *nymphaeum,* or fountain room. Here, on one side, water flowed from the wall over thin slabs of marble



Portrait bust of Themistocles

4th Century Christian basilica

overlapping in the style of our slate or tile roofs. Below, there emerge some pipes, probably showing that water also flowed from terminal heads of fish or animals such as often provide the inlets for our modern swimming pools. In the background, a columned arcade, comparable in style to renaissance loggias, forms the only surviving decorative feature of the fountain. In the foreground, a small plot of grass touches off the scene, and one can well imagine that it was a handsome and lively fountain that some wealthy citizen of Ostia built here.

In general, the streets at Ostia are laid out according to a very regular plan. But among the recent excavations there lie close together three temples whose orientation is quite haphazard. All these temples show, at a lower level, platforms which, perhaps, go back to the 2nd Century B.C. The largest of them has a dedicatory inscription to the god Hercules.

The new excavations have brought to light many interesting pieces of sculpture—statues, portrait busts, and reliefs. The most recent finds are placed in a large vaulted room of one of the ancient buildings. One of these is a large statue of the oriental god Mithras slaying a bull, a common Mithraic motif. Shrines of Mithras are always turning up at Ostia. There are also in this room a statue of the emperor Trajan wearing a cuirass of unique style, a portrait bust (see photograph) inscribed "Themistocles," the curious nature of which has given archeologists some trouble; also, reliefs of shop scenes, and a relief possibly representing the birth of Minerva from the head of Zeus. A small permanent museum houses the sculpture, inscriptions, and small objects previously found. Of the inscriptions, the fragments of a Roman calendar discovered a few years ago are the most important. There also is a fine collection of portrait heads.

The most spectacular event occuring at the dig was the discovery of a 4th Century Christian basilica on the north side of the main street (see the illustration). This building had a vestibule with an entrance formed by two arches, a type which one naturally compares with old churches in Rome having porticos. The features of chief interest in it are a baptismal basin and an architrave on which are inscribed the Christian monogram and the names of four Biblical rivers, including the Tigris and Euphrates. The basilica has two apses and two naves separated by a row of columns, and on the eastern side there are several rooms that must have been side chapels.

The last chapter of imperial Ostia's history was not a spectacular one, when compared with that of Pompeii, a city which was completely lost in one of the world's major catastrophes, and the recovery of which has therefore been widely publicized. For Ostia was never completely lost, but suffered a gradual and pathetic decline as the result of neglect and plunder. Early in the imperial period the first artificial port was built at the mouth of the Tiber to replace the port of Ostia, which was no longer adequate to handle the volume of trade between Rome and towns beyond the seas, but it was not until the reign of Constantine the Great, in the 4th Century A.D., that this new port was favored so completely as to exclude Ostia entirely from commercial traffic between Rome and the sea. The more interesting is it, therefore, that in this period of the city's decline a Christian basilica of considerable size was superimposed on remains of pagan buildings.

Not long after the erection of this church, Ostia became associated with one of the great figures of church history, for it was to this town that Saint Augustine came with his mother, Saint Monica, to take ship for his home in Africa after his conversion. Saint Monica never sailed, for here —as Augustine tells us in the ninth book of his *Confessions*— after nine days of illness, she died. Her death took place in a little inn overlooking a garden. Such a garden one may see today in Ostia, giving warmth and life to the ancient bricks and mortar that surround it. Archeologists like to think that now they may look upon the garden of the little inn where the devout Monica spent her last days, and they like to think, too, that perhaps the saint and his mother stopped and worshipped in the little church which still stands there.

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FOSSIL

World's Oldest Evidence Of Animal Life

Earliest known record of animal life on earth may be the fossil imprint of a stranded jellyfish on a slab of fine-grained red sandstone now in the geological collections of the Smithsonian Institution. It came from pre-Cambrian deposits at the bottom of the Grand Canyon of Arizona, which are more than half a billion years old.

Dr. R. S. Bassler, head curator of geology at the United States National Museum, states that the imprint has all the appearance of having been made by a jellyfish. It resembles jellyfish fossils of Cambrian age, earliest period from which animal remains are at all numerous. It also resembles the dried-up stranded jellyfish washed ashore on modern beaches. There are ripple-marks, as of an ancient beach, on the Smithsonian specimen, and the lobed structure of the animal is impressed on these.

Pre-Cambrian rocks are singularly empty of traces of animal life, despite the high probability that the earth had inhabitants at that remote time. During the Cambrian age, which began about 550,000,000 years ago and lasted 70,000,000 years, there were abundant animals, representing practically all of the major zoological groups except the vertebrates. This argues that a long period of evolution must have preceded the Cambrian. But for some reason (possibly the lack of lime in the waters of those days) they have left no shells or other hard parts by which they could be recognized. Hence the great scientific interest of the jellyfish markings on the ancient stone slab.—*Science Service.*

No Mystery In Pep

Seven Simple Rules for Getting and Maintaining a Reserve of Vigor

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Do you have more horsepower than you need for the day's activities?

Your automobile quite likely has much more horsepower than is usually used. This is reserve power, power which gives it pep. Some energetic people, also, have more energy than they use up and can finish the day with as much pep as they began it.

The chief source of this human horsepower, this reserve of vigor, comes from protective eating. Everyone understands the importance of foods, but few realize the relationship which exists between what they eat and how vigorous they are. Those few who are aware of the influence that the daily foods have on one's daily pep, often go off on a tangent; they become food faddists, and try to subsist on some fearsome combinations, such as honey and clabbered milk. Or, they hear about some fanatical, but impressive, dietary cult, and religiously follow its leader, avoiding combinations of food which he claims are harmful.

It is a scientific fact that these dietary cults, almost without exception, are injurious to vigor and pep. Yet human nature seems to like to embrace all kinds of new and silly fads, instead of old, monotonous, scientific truths. I think one reason for this is the ease with which a fad can be remembered — avoid carbohydrates and proteins at the same meal, to quote from one cult. Now that surely is easily remembered and easy to practice, but it has no scientific merit.

Scientific rules, in contrast, are usually complicated, loaded with chemistry and strange weights, and completely bewildering to the average person. Protective eating, however, can be reduced to simple rules, which require no chemical knowledge, and do not tax the memory. In this article we shall take up rules for protective eating, or *Rules for Getting a Reserve of Vigor*. These rules will be reduced to such simple and essential terms that any average adult can remember them, and follow them with little effort, and then can learn to conserve the same vigor after getting it.

Rule 1: **Eat three different vegetables a day**

In this era of highly refined, ready-prepared foods, quick lunch sandwiches at the soda fountain, nine people out of ten do not get sufficient vitamins and minerals in their daily food. The vigorous pioneers of a century ago got a more adequate supply of vitamins and minerals than do their pepless descendants of the present day. Even the prisons and almshouses of the 17th and 18th Centuries, dismal and unsanitary as they were, served food which made for more vigor than the wealthy get in their luxurious clubs today.

Moderns need to watch carefully to make certain that they get three different vegetables a day so that they may keep up a reserve of vigor. The vitamins and minerals give a little extra horsepower, which is sorely needed by almost everyone. (Potatoes, whether white or sweet, do not count in this discussion, as vegetables.)

The vegetables do not need to be fresh; canned will do just as well. They can be in soup. They can be raw, or cooked, or warmed over. It is not complicated — just remember three different vegetables a day, in addition to potatoes.

It is helpful to have one of the vegetables of the leafy variety, such as lettuce, cabbage, broccoli, or even spinach.

Some time ago a 35-year-old advertising man who had suddenly found himself making big money, confessed to me privately that he felt himself slipping. He was worried because his thinking was slowing down, as were his movements — he felt tired all the time. In addition, he was bothered by a little rash, on which he had tried all sorts of patent ointments.

He did not realize, until it was pointed out to him, that his new prosperity was the cause of all this. The rash, his failing memory, and increasing tiredness, were all indications that he was violating the Rules for Getting a Reserve of Vigor. Since he had been earning a fat salary, he had been indulging in his lifelong suppressed desire to eat all the steak he wanted. Five nights a week he would feast on a double steak, a dill pickle, and a thick slice of pie. He was putting on a little weight, and thought that was a sign of good health. Occasionally he would have one vegetable at lunch, but more often he had none.

He did not dislike vegetables. He merely wanted to eat the more expensive foods which he now could afford. Of course, his diet was seriously off balance. His rash was apparently a dietary dermatitis. The rash, the slowed thinking, the peplessness, and his bowel trouble, all cleared up within a month after he began to practice these rules. He still had his steak, but it was smaller to make room for two vegetables every night. The story has a happy ending, for he is still in big advertising money. In fact, six months after he began to follow these rules he was given an increase—and he had been definitely on the skids only a short time before he was slowing down—the result of eating too well, rather than wisely.

Rule 2: **Eat two fruits, or fruit juices daily**

These are also necessary for their vitamin and mineral content, in addition to their moderate regulatory action. As with vegetables, the fruits can be either canned or fresh.

The value of the excellent, modern, refrigerated, fresh fruits and canned juices which have been on the market in quantities only since about 1930, cannot be overestimated for their vigor-renewing value, as well as their luxurious time-saving quality. In contrast, we remember grandma as she used to sweat over her stew kettles canning fruits during the ripening season.

Either the fruits, or the juices, can be used as a between-meal snack, as well as at mealtime. It does not matter when they are taken. A good New England custom, for example, is to eat an apple just before going to bed.

That advertising executive who was slipping now indulges his luxury with a large glass of fruit juice each morning, served on a silver tray while he is shaving. I drink my own glass before I leave the house, to climb Blacksmith Hill Road for the mail each morning, and then come home for breakfast. We always have a dish of fresh fruit in the laboratory for a between-meal snack.

It is easy to get two fruits a day —and equally easy to remember the rule.

Rule 3: **Eat eggs and milk once a day**

These are nourishing foods, as well as protective, but people tend to forget them. They were mainstays in the diet of John D. Rockefeller, Sr., and he did not have a false tooth in his head at the age of 97 years. He would often stop during a round of golf to drink a deep glass of cool milk.

People often ask me if one does not get enough eggs in one's cakes and puddings. The only eggs that count for those who follow this rule are those that do not conceal their identity—an egg that looks up, smiles, and says, "Hello, I am your egg." The only camouflaging the egg can undergo and still count is in an egg-custard. It does not matter how the egg is cooked—it can be deviled, or a pickled egg in the tap room—but it is easiest on the stomach if it has been cooked at the lowest possible temperature, and not very long.

I am also asked if people do not get adequate milk in their puddings. This concealed milk does not count with these rules. The only way the milk may be disguised is in chocolate milk, milk stew, or as cheese. At lunch this noon, for instance, I ate a 12-cent carton full of cottage cheese: A little square of cheese means nothing—it must be a man-sized piece.

That advertising genius who started to skid now drinks a bottle of chocolate milk in the middle of each afternoon, in place of the bottle of imported sparkling water he used to affect in his outburst of first prosperity. He also is pleased with the rule's recommendation of cheese, since it gives him an excuse to order the most rare and expensive varieties with his evening apple pie. (He still wants me to count that pie as one fruit!)

Eat anything else you want, but make sure you get the essential three vegetables, two fruits or juices, egg and milk, as a basic diet every day. These need emphasis as they are the things folks tend to overlook—few need to be reminded to eat meats and desserts.

Rule 4: **Drink enough water to make your urine a light straw color**

Eight glasses of water a day have often been suggested as the ideal quantity, but some people need more water, and others need less. The best index, and one that is easily followed, is to watch the color of the urine; if you are getting the right amount of water, the urine should be a light straw tint.

Many people avoid water with their meals, in the false belief that it dilutes the gastric juices and slows down digestion. As a matter of fact, however, experiments show conclusively that digestion is actually helped when water is taken along with the food.

Most of the water people need can be taken during the day, before the evening meal, and then one's sleep need not be disturbed by bladder distention. A glass of water, or fruit juice, is desirable the first thing in the morning.

We have water piped from a protected spring on the hillside to our laboratory. Deliciously cool the year 'round, we take many small drinks of this throughout the day, in addition to having it with meals.

Alcoholic drinks contain a large percentage of water, but water disguised in liquor does not count. The alcohol may make a person forget his fatigue temporarily, but it leaves him in a less vigorous condition after the stimulation wears off. For those who must have their drink, cheap gin, or Scotch whiskey have the least undesirable after-effects, especially if one drinks them in plain water.

Rule 5: **Relax residual tensions before, during, and after meals**

"Business man's stomach" is usually attributed to restaurant cooking. Restaurant cooking may not taste like grandmother's, but it is all right, and should not be blamed. The person himself is usually to blame, for he takes his business and his worries to the table with him. He eats in a tensed condition, instead of the ideal, relaxed condition.

Belching, indigestion, a heavy feeling in the stomach, and bowel disturbances are all caused, at times, by lack of relaxation at mealtime. Some specialists claim this to be the outstanding cause of these vigor-sapping troubles.

I find that folks can remember this rule most easily if they get in the habit of relaxing residual tensions every time they see food or a dining table. Even the sight of someone else eating a candy bar should be a reminder to relax those usually present residual tensions around the jaw, around the eyes and forehead, and on the back of the scalp between the ears.

It is not primarily a question of eating slowly, but of being relaxed in body and mind. Relaxing the residual tensions assures a relaxed spirit, and that is the mealtime goal to be sought.

Rule 6: **Get one hour of sunshine daily**

Five hours of sunshine and a sunburn the first day of vacation do not count. It is the regular daily exposure to the Sun's rays that gives real help. As much of the body as possible should get the kindly rays. I often walk with my hat in my hand in order to have more area exposed to the sunshine. Many city workers, unfortunately, cannot get an hour of natural sunshine daily, so the farmers outclass them in vigor.

It is also difficult to get natural sunshine on much more than the tips of the nose and ears in the winter months, although the entire body would benefit by it. Artificial sunshine lamps can be of service in overcoming this dilemma. If you buy one, make certain that it is approved by the American Medical Association, otherwise you may be buying some wires and switches which appear impressive, but which yield no real benefit. An hour is too long under such a lamp; the book of instructions will tell you how long is safe.

The vigorous, young general manager of a silverware manufacturing company is one of thousands who lets a sunshine lamp help him keep his vigor at a high peak. Each evening before dinner he undresses, takes a 20-minute sun bath, relaxing all the while, and gets up irradiating sunshine himself.

The Sun's rays, as with the three vegetables and two fruits a day, the eggs and milk, plentiful water, and mealtime relaxation, will not produce instantaneous results but 95 out of 100 people will notice definite results in improved vigor sooner or later. How soon depends largely upon the person, upon how starved his body has been for these

neglected essentials, and how faithfully he follows the rules every day—including Sundays and Saturday nights. A single breech of the rules may set one back a couple of weeks.

It takes a week or two for the average person to notice clear-cut results from following these rules. We can't expect to remedy a lifetime of maltreatment of the sources of vigor overnight, especially if we realize that even a week's maltreatment may require a month for recovery.

Rule 7: **Have a complete check-up once a year by a physician and dentist**

Automobiles are examined and tuned up periodically, oil changed, batteries checked—all preventive measures to avoid breakdowns, and to avoid any loss of vigor and pep. People, also, should be looked over at regular yearly intervals. Eyes and teeth, as well as the rest of the body, should be thoroughly examined. Those who wait until there are pains, toothache, noticeable eye strain, are locking the garage after the car has been stolen. Minor physical defects which develop from time to time must be caught early, before they have been able to undermine vigor seriously.

People who are pepless and habitually fatigued should have a basal metabolism included in their examination to discover whether, perchance, a sluggish thyroid is responsible for their lack of vigor. If it is, a glandular prescription usually remedies the condition easily, and restores the vigor.

Many firms require these complete physical examinations once or twice a year for all key employees. The company does not want to take a chance—it costs too much money when an important executive loses his vigor.

One of my closest friends has been very thankful because I insisted that he have a complete examination when his peplessness seemed unexplainable. His physician found nothing, but the dentist discovered some apical abcesses which, when cleared up, seemed almost miraculously to restore him to his old vigor. Another needed eye attention. He had felt that he might need glasses for some time, but shunned an examination because he said, "Glasses make men look like sissies." I pointed out that the real sissy was the man who lacked nerve to wear them.

With another it was a sluggish thyroid, detected by the metabolism test. He is one of our foremost public speakers—you would gasp if I mentioned his name. His successful career was at stake, because pep and enthusiasm are indispensable for a public speaker. He could no longer even pretend to be energetic on the platform. Audiences that had formerly listened eagerly for each word began to grow restless. Glandular prescriptions made up for the slight deficiency discovered in his thyroid and he is again the popular, enthusiastic speaker.

I am often asked about the usefulness of many common "fatigue remedies" and "pep preparations." Here is a brief summary of current scientific evidence on these:

Yeast, in almost any form, gives renewed vigor. It will seldom be needed, however, by people who follow the rules we have given.

Coffee and tea contain substances which give a temporary boost by lessening the feeling of fatigue for a couple of hours. They do not remove the cause of the fatigue which still remains to sap vigor. "Cokes" are essentially the same as sweetened coffee. Their caffein gives the same passing lift, but does not make up for lack of vigor.

Sugar and candies will give heavy muscular workers some needed "quick energy" about a half hour after being eaten. People who are in sedentary work may find that these decrease their vigor, however, since they may add more weight, and thus more effort is required to move.

By following the seven simple rules outlined above, the middle aged can regain much of their lost vigor, and the young will go much longer before losing their youthful vim.

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YARDSTICK

For Planning the Daily Diet

Americans now have a scientific yardstick for planning the daily diet that will give them health, strength, and morale for total defense. The yardstick, translated from laboratory terms of allowances for vitamins, minerals, protein, fat, and carbohydrate, was announced by Dr. Lydia J. Roberts, head of the department of home economics of the University of Chicago, as follows:

One pint of milk daily for an adult, more for children.

One serving of meat.

One egg daily, or some suitable substitute such as beans.

Two servings of vegetables daily, one of which should be green or yellow.

Two servings of fruit daily, one of which should be a good source of vitamin C, such as the citrus fruits or tomatoes.

Bread, flour, and cereal, most and preferably all of it whole grain or the new, enriched bread, flour, and cereals.

Some butter daily, or margarine with vitamin A added.

Other foods to satisfy the appetite.

Cheaper cuts of meat, Dr. Roberts reminded, are just as nourishing as the more expensive ones.

NOISE

Ear Plugs Protect Industrial Workers

Fatigue, irritability, and nervous exhaustion experienced by workers in or about noisy operations are lessened by the use of Ear Defenders, plugs which reduce loud noises by 35 to 45 decibels or to about 1/10 their former loudness, yet are so designed that warning signals and conversation can easily be heard. The resulting effect from the reduction of noise, it is claimed, will enable the workmen to better concentrate on their jobs and thereby increase their efficiency.

Essentially, each Ear Defender, made by the Mine Safety Appliances Company, is a tapered tube molded from surgical-type soft rubber. Each consists of two barriers, an outer one of metal and an inner one of soft rubber, separated by an air space. The tapered construction permits easy insertion and removal without any danger of coming in contact with the ear drum. The devices can be easily cleaned with soap and water, thus insuring a sanitary article at all times. The cost to the user is thus relatively low in comparison with other ear protectors which must be discarded after being used a short time.

The plugs were designed by Dr. Vern O. Knudsen, an authority on acoustics, and Dr. Carey P. McCord, an industrial health expert.

For Better Paint

Methods of Testing Surface Coatings for Metals Have Definite Place in Maintenance

IF THERE'S a paradox confronting every maintenance engineer engaged in testing and selecting metal protective paints for general maintenance work, it might be expressed as "making haste slowly." For, although it is true that accelerated tests provide the engineer with much information about a coating that it would otherwise take many years to obtain under actual service conditions, it is equally true that many accelerated tests may produce results that are not typical of exterior exposure or normal service. Hence a balance must be struck, and a combination of tests must be used, as a brake to guard against the ever-present possibility that a really worthwhile coating will be discarded and an inferior coating will be adopted, on the basis of performance in an isolated test of no practical significance. In other words, the aim of all testing work should be to provide a composite picture of a paint's performance rather than one phase of it.

Because in "weather" lies the ultimate answer to the durability of most metal protective paints, every engineer has had to ask himself the question, "What is weather?" The plain and simple answer is that it is variable, unreliable, and constantly changing. Montana's weather means armpit-deep snow in winter and blazing hot sun in summer. Atlanta, Georgia's, weather includes, among other things, a mean yearly precipitation of over 48 inches, and very little of it snow at that.

Tide-water tests of painted panels, such as that shown above, call for careful preparation of the test panels and require expert interpretation of the results

● Protection of metal surfaces by paint coatings to prevent corrosion assumes even greater importance as the need increases for conservation of materials and economical maintenance of structures. Yet, as the accompanying article points out, engineers responsible for this work must exercise care in their interpretation of the tests that have come into wide use, correlating results so as to reach a final decision which will be based on a consideration of all the factors that affect surface coatings.—*The Editor.* ●

For many a maintenance engineer, it is a perfectly logical procedure to forego normal weathering panel testing and apply a test section of metal priming paint to an actual structure. While a single exposure of this type cannot be as indicative as desirable, multiple exposures of the same nature on properly prepared surfaces provide a comprehensive background with which there cannot be any argument.

Next best thing to testing a metal protective paint under actual service conditions is to expose test panels of it to the weather, usually on racks facing south to insure the maximum amount of sunshine. Panels of non-copper-bearing black iron are generally employed. Simple as "normal" weathering exposure may seem, it is not without its pitfalls. For example, many of the best metal priming paints are so formulated that they have characteristics which make them totally unsuitable as finishing paints or for lengthy exposure to the weather. However, when properly protected with suitable finishing coats, they do a splendid job of protecting the metal

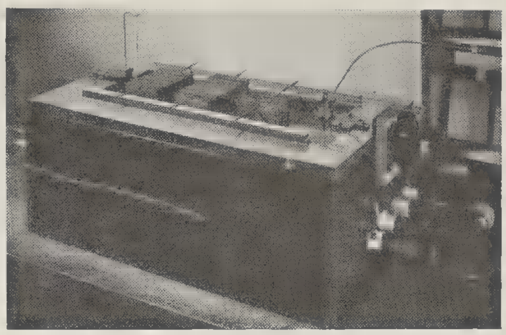
Sub-Tropical Testing Service

A test panel fence, facing south to insure maximum sun exposure, is of particular use when complete painting systems are to be tested against each other

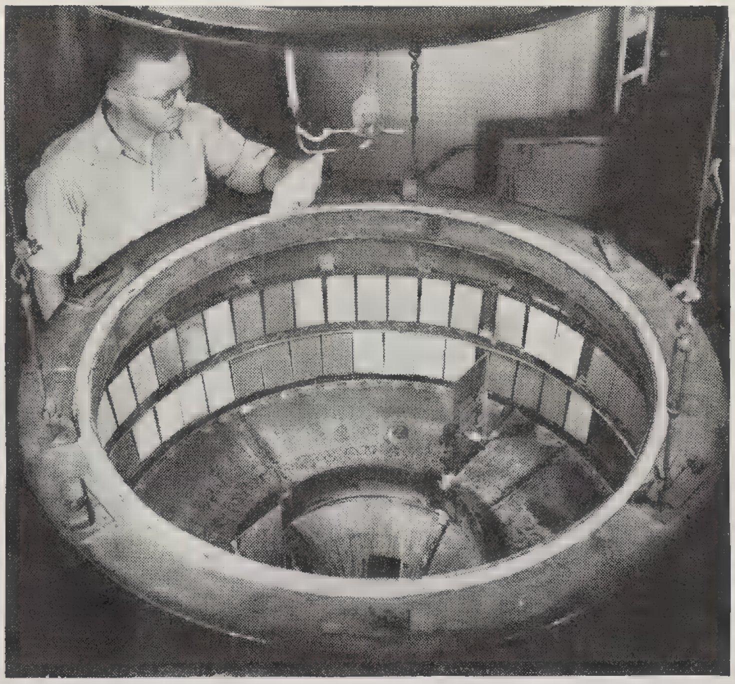
underneath. Hence, single-coat weather exposures of metal priming paints to the weather, although proceeding with greater rapidity, can sometimes be misleading unless supplemented by test surfaces finished according to the painting system used in ordinary practice. Of course, this same precaution also applies to other test procedures.

Time was when little attention was given to the nature of the metal panel itself. More recently, studies have shown that the nature and extent of the mill scale on the metal surface have an appreciable effect on the performance of metal priming paints, and that this effect is not the same for all paints. It is also claimed—and practical knowledge would seem to support the claim—that the nature of mill scale present on metal test panels is different from that existing on structural steel shapes such as "I" beams, angle irons, and so on. Since the ultimate aim of metal protective paint-testing work is to simulate the conditions which exist on a structure (where some mill scale is nearly always present), it is but a step removed from such conditions to make test exposures of paints on sections of structural steel members. The procedure has so far been applied mostly for determining the suitability of metal priming paints as shop coats, but further extensions of its use would seem likely except where the lack of portability and bulk of the tests is a major objection.

Outdoor weathering tests are slow at best, and to speed up results various types of accelerated tests are used. Exposures on Florida tidewater test racks provide one type of accelerated test which gives much useful information, especially where the durability of marine coatings is concerned. Because of the severity of the test, which consists of placing test panels on racks so that they are alternately exposed to salt water and Florida sun, failures occur within a relatively short period, usually from 1½ to 2 months. The test provides a more or less fixed set of conditions to which some paint coatings are more susceptible than others and this, coupled with the speed of determination, makes it a valuable supplementary test method. However, its highly accelerated nature calls for care in controlling such factors as the preparation of the panel, and warns against drawing broad conclusions from moderate differences in results.



Immersion tests provide clues to service in presence of moisture

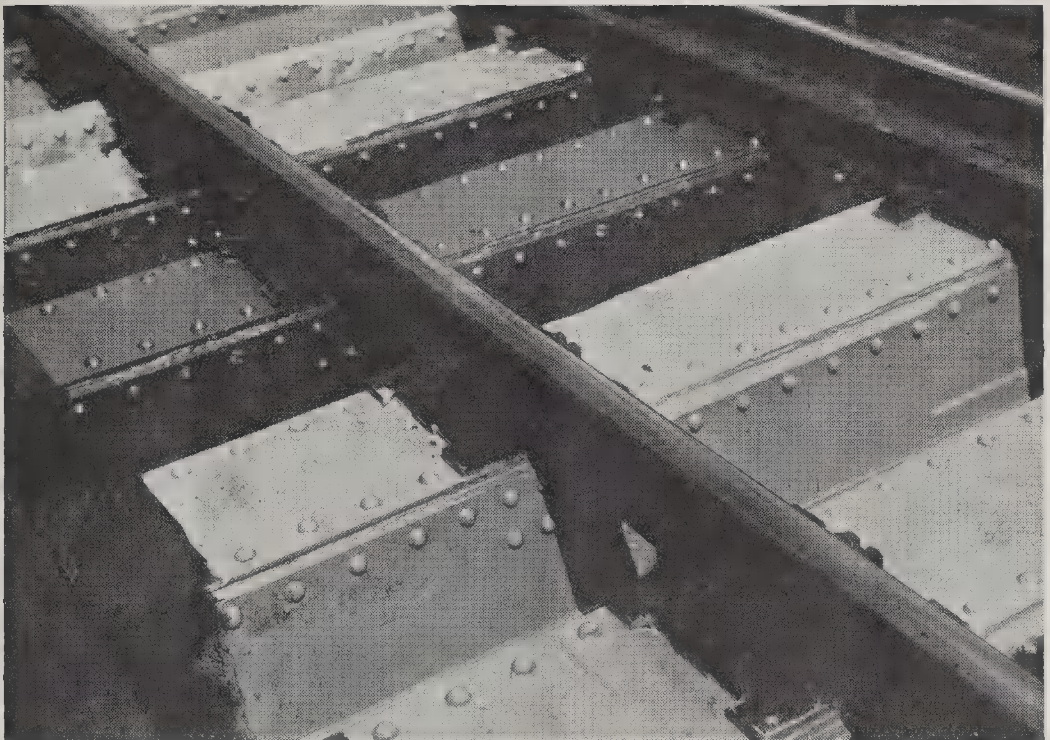


In accelerated weathering tests, all factors must be intensified in correct proportion to each other

Another form of accelerated test which has come into extensive use is the so called laboratory accelerated weathering machine. Basically, it makes provision for the exposure of test panels in a predetermined sequence to a mercury arc lamp (to simulate sunlight), humidity as developed by atomizing warm water in the tank, water spray to simulate rain, refrigeration to provide low temperatures, and a combination of sulfur dioxide and carbon dioxide gases similar to that encountered in industrial locations.

The purpose of the machine is not to simulate and strike an average of the weather in any one locality, but to intensify, within reasonable limits, each and every one of such weathering factors, and thus to reproduce in a relatively short period failures which can be interpreted in terms of actual service. Notwithstanding the vagaries of actual weather, "artificial" weathering as obtained with accelerated weathering machines is of real benefit in testing work, provided no one weathering factor (as, for example, light) is intensified to the point where the balance between all factors is lost.

Exposure of metal priming paints, or more particularly metal finishing systems, to chemicals



Many authorities on paint problems prefer small-scale tests under actual service as here, where structural members are given different coatings

(acids, alkalis, brines, and salt sprays) is never desirable unless these represent actual service conditions. Among tests which are designed to reproduce and measure one particular type of failure, laboratory immersion tests (salt or fresh water) are useful in determining the tendency of metal priming paints to blister under moisture conditions, which are nearly always encountered in actual service.

Difficulty is sometimes experienced in grading the performance of a paint if a number of individuals are making observations of the results. The American Society for Testing Materials is now attempting to establish so called pictorial "rusting standards" which, if finally adopted, may become the universal language every paint technologist and engineer can use for designating degrees of corrosion. And that will mark another forward step in the already progressive field of corrosion prevention.—Courtesy *Paint Progress* and the New Jersey Zinc Company.

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CLOUD CHARGE

Indicator Will Assist in Studying Upper Air

A DEVICE for indicating to airplane pilots the intensity of electricity in a nearby thundercloud, illustrated in laboratory form on page 54, is called a "Cloud Charge Indicator for Airplanes." It is a delicate instrument containing a neon tube and a microammeter and can be mounted on the panel board of the plane. The glow of the neon tube serves as a signal for the pilot.

The instrument is connected to a pointed tungsten rod similar in size and shape to a lead pencil and protruding 14 inches from the plane. The glow of the neon tube rod picks up the electrical discharge from the cloud and sends it through the instrument. This causes the neon tube to flash and the meter needle to deflect. The amount of this deflection indicates the intensity of the electrical disturbance ahead and permits the pilot to change or maintain his course accordingly.

In the laboratory, an artificial cloud-plane arrangement was provided. A brass sphere, about two feet in diameter, was suspended a known distance above a tungsten rod which was connected to the cloud charge indicator. The sphere served as the cloud; the rod, 14 inches high, served as the airplane. Voltages of known magnitudes were passed through the "cloud" and the instrument readings noted. The voltages, or electrical pressures, per linear foot in the atmosphere, were calculated for any given reading on the instruments. Data also were prepared for a six-inch rod. From these data, charts were prepared for use by the pilot of the plane.

It is hoped that records of the intensities found under various atmospheric conditions and at varying heights from the clouds and at various plane speeds will be kept by the airlines using the instruments. This would provide research engineers with additional data for the study of lightning phenomena.

The instrument, consisting of a double-scale microammeter, glow tube, resistors and capacitor, is designed to register up to 400 microamperes.

CANAL LIGHTING

Sodium Vapor Units For Cape Cod Waterway

DELAYS caused by fog and other adverse weather conditions have been practically eliminated in the Cape Cod Canal as a result of sodium vapor lighting. Saving 65 miles on the New York-Boston sea route, the canal, 7.7 miles long and 500 feet wide, connects Massachusetts Bay at Sagamore with Buzzards Bay at Bourne.

After considering various light sources, sodium vapor lamps were found best able to meet the lighting requirements during foggy or misty weather. For this purpose, the lamps have a distinctive yellow color that is not confused with other artificial lighting. Installed at 500 feet intervals and mounted on pole crook brackets, the luminaires are Westinghouse "Reflectolux, Sr." with bronze globe holders and fittings to withstand salt air. The complete installation consists of 146 units with 10,000 lumen sodium lamps. Circuits are sectionalized so that in event of failure in one circuit, half of the lights on each side of the canal will still be operating.

STORED SEED

Germinate Even After Eight Years

INTEREST in locating good seed stocks for 1942 plantings has focused attention on tests made in the seed-testing laboratory at the State Experiment Station at Geneva, New York, on seed oats and seed barley held in storage for as long as eight years. Several stocks of both oats and barley germinated 98, 99, and 100 percent, while other lots showed less than 90 percent germination, according to Dr. Willard Crosier.

While farmers are not likely to have to use seed stocks as old as these, yet in the spring of 1937 a

Sodium lights defeat fog dangers

large group of farmers in central New York found it necessary to use seed oats that had been in storage from two to four years. Evidence that oats and barley seed will retain their vigor and viability over comparatively long periods of time is reassuring in these days when the demand for increased production is so pressing.

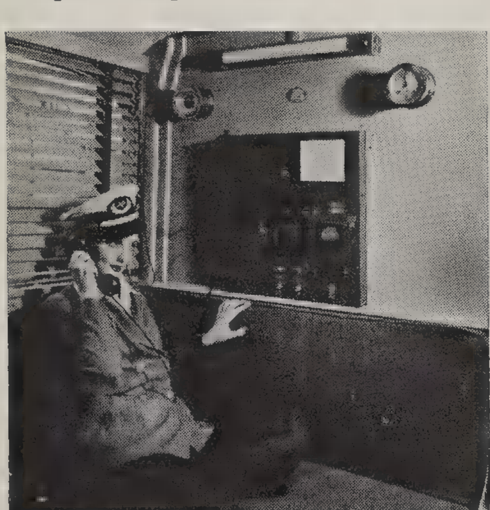
YACHT

Ultra-Modern All-Metal Cruiser Makes Trial Runs

YACHTING and marine enthusiasts, as well as the Navy and the Coast Guard, are displaying intense interest in a new type of 45-foot yacht cruiser which recently made her maiden voyage of 168 miles at an average speed of 27 miles an hour. Powered by twin 315-horsepower engines, this new boat, the *Revere*, can attain a speed at full throttle of just under 35 miles an hour. This makes her one of the fastest cruising yachts of her size in the country.

The interest being shown in this new vessel is accounted for by her unique design. One of the factors contributing to her speed is a completely new conception in hull shape, a conception that could never before satisfactorily be realized in a wooden boat. The *Revere* is of all-metal construction—hull, deck, and cabin—and hence her designers could build into her the optimum lines for speed and fuel economy without having to compromise with the limitations of a semi-rigid material. Thus the *Revere* incorporates without change the theoretical lines adapted from models tested at the Stevens Institute test tank.

The streamlined *Revere*, an all-metal yacht of unique design



Two-way radio equipment aboard the *Revere* is designed to use ten crystal-controlled waves

The hull, deck, and superstructure of the *Revere* are all made of cupro-nickel sheets just a bit over 1/12 of an inch thick. This material, of which Revere Copper and Brass, Inc. has made condenser tubes for naval and merchant vessels for many years, is known for its almost perfect resistance to salt-water pitting and corrosion. It is this resistance to corrosion that has helped to make possible the use of thin and light plates. In the past, metal boats have been forced to use heavy plates, resulting in high cost and loggy performance. In the design of the *Revere*, all of the metal was figured in design and strength calculations, it being unnecessary to make discounts in consideration of corrosion.

In the construction of the *Revere*, pre-shaped sections of the metal were laid according to plan in a previously prepared wooden form. They were then joined by welding, resulting in a "one-piece" boat.

The *Revere* is completely equipped with radio for both transmission and reception. Ten crystal - controlled transmitting and receiving channels, provided by a standard Hallicrafters marine radiophone, include those for ship-to-ship, Coast Guard, and ship-to-shore communications. This radio equipment offers automatic voice-controlled transmit - receive changeover, instant choice of services by simple selector switches, and operating simplicity approaching that of the ordinary home telephone. This radio equipment has a communication range of several hundred miles, in spite of antenna limitations imposed by the boat's low lines and the midship location of the apparatus.

ANCHOR

Plastic Secures Fastenings In Holes

SCREWS, bolts, nails, and hooks can be held permanently in place in wood, concrete, plastics, and so on by the use of a new plastic material known as Sy's Plug. This material is used to fill holes, after which the fastening is driven into place. The plug is formed by rolling the plastic material between the fingers into a size that will fit the hole. It is then dipped into water and pressed into place. Then the screw or other fastening is driven into the plug, which hardens permanently to anchor the fastening in place. The plastic can be also used as a repair material for screw holes from which the threads have been stripped.

TRUE "DRYS"

Animals That Gain All Needed Water Chemically

THAT certain animals have solved the problem of living without drinking water is the contention of Ernest P. Walker, Assistant Director of the National Zoological Park, in the latest annual report of the Smithsonian Institution. Through long periods of evolution, he says, they have developed means of surviving with a minimum of mois-

ture so that today water seems abhorrent to them.

The most specialized of these animals are some of the rodents such as the pocket mice and kangaroo rats of the southwestern United States and the jerboas of Asia and northern Africa. "These animals," Mr. Walker explains, "live in regions where the rainfall is very scant over much of their range, and where water is practically unobtainable. They have, therefore, become adapted to living with almost no water or drink. During the very short time when there is green vegetation they may eat some of it. At other times they obtain no moisture except, perhaps, an occasional drop of dew. But their needs are adequately supplied by chemical processes that take place within their own bodies, where the constituents of dried seeds and other vegetable foods are converted into moisture by oxidation.

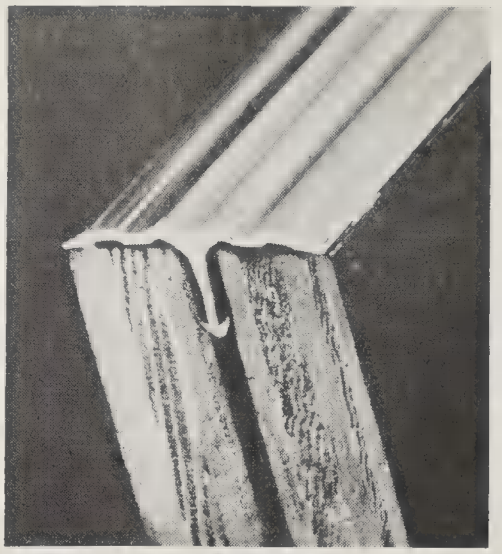
"I have often offered water to pocket mice, kangaroo rats, grasshopper mice, and other desert animals to make certain they did not suffer from lack of moisture. Almost invariably they refuse it, although occasionally they may sip a little and then not touch moisture again for months.

"One pocket mouse seemed greatly offended when I offered her water. On a few occasions I dropped a single small drop of water on her and was much amused at her violent antics of rolling in the sand to remove the offending substance from her coat. I am convinced that she never took water during two-and-a-half years. Very rarely did she show any interest in eating any moist vegetation. In the case of such a carnivorous rodent as the grasshopper mouse, the blood or body fluids of its victims would supply one of these animals with most of its required moisture."

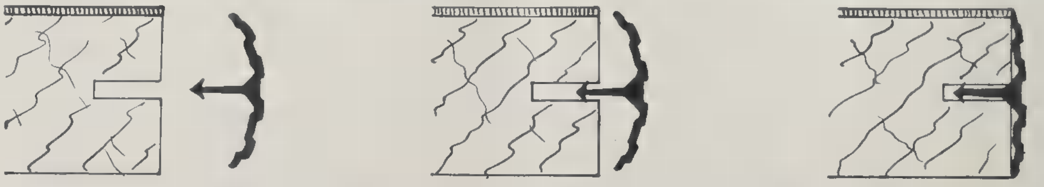
INTERLOCKING

Plastic Strips Replace Metal Trim

EXTRUDED plastic shapes are finding ever widening use in a variety of applications where they replace metals. One of the latest developments in this field is an edging material designed for use on tables, shelf trim, counter edges, and wallboard joints. Illustrated herewith, this new strip form, produced in long lengths, locks into position without the use of adhesive, screws or other means of attachment. Wherever a slot of the proper width can be provided, this "Interlox" section can be quickly and easily applied. When the material is pressed into place,



Above: **Extruded plastic trim in place.** *Below:* **How trim is held in position by barbed extension**



the barbs hold it in position. The material used in the "Interlox" strip is Tenite II, produced by the Tennessee Eastman Corporation. It is available in a wide range of colors and has a horn-like toughness and a high luster. The surface is washable in soap and water, requires no polishing.

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GASOLINE: Motor fuel for highway use totaled 22,000,000 gallons in 1940 and for non-highway purposes 2,000,000,000 gallons, according to state reports compiled by the Public Roads Administration.

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SEALING

For Cracks In Water Jackets of Gasoline Engines

SUPPLIED in liquid form, a new sealing material for water jackets and radiators of gasoline engines is claimed to find and seep into cracks and then to congeal into a hard metal-like substance on contact with air. This material, known as Whiz Weld Metal, is claimed to flow readily in the circulation system of the engine and not to clog water passages or circulating pumps.

FROZEN COFFEE

Process Reduces Bulk, Preserves Flavor

DESIGNED to render a joint service to the packer, distributor, retailer, and consumer in the general food line, a new method of processing and packaging foodstuffs is the recent invention of John C. Donnelly. It involves a combination of two methods of preservation—rapid refrigeration and compression.

Immediate application of the process for public consumption will be confined to the coffee market. Coffee processed under the Donnelly patent will reach the consumer in cellophane-wrapped compressed and refrigerated blocks, each two inches by two inches by one half inch, packed 20 to the pound. The consequent reduction in cubic displacement will cut distribution and storage costs.

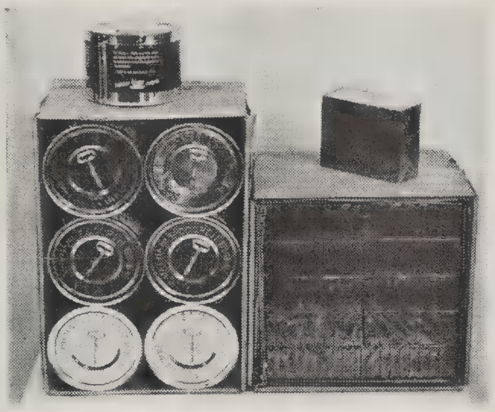
The reduction exceeds 50 percent, according to the inventor, who points out that an ordinary carton used for transporting 12 pounds of vacuum-tinned coffee will accommodate 30 pounds of the refrigerated product.

In its preparation, the coffee is first refrigerated directly from the roasting oven to a point 20 to 30 degrees below zero, Fahrenheit. A state of "suspended animation" is thus created, sealing the volatile oils in the bean itself.

While in this "anesthesia," the coffee is ground and compressed into blocks and maintained in the frozen state until it reaches the consumer. At home, it is again placed in the refrigerator. The volatile oils that account for the taste and aroma of coffee will retain their solidified state and the coffee will remain fresh indefinitely so long as it is kept in the refrigerator.

An added advantage claimed for this process is that the particles of the ground coffee are fractured by the compression in such a manner

as to permit a greater aqueous extraction, enabling the user to obtain 15 to 20 more cups to the pound than usual. It is estimated that the average user of coffee in the conventional form throws away 30 percent of yet usable cof-


12 pounds canned: 20 pounds frozen

fee in disposing of the "grounds", Mr. Donnelly points out.

Each individual unit of the new processed coffee is a measured quantity, thereby eliminating one haphazard operation by the consumer. Although in compressed form, it is sufficiently friable for convenient home use.

TNT

Being Made 70 Percent From Petroleum

DEFENSE needs for TNT explosives are being supplied for the most part from toluene made by the petroleum industry, in plants now operating or that will be in operation within a few months. The annual production of toluene from the plants now operating and under construction totals 100,000,000 gallons, enough to make 1,000,000,000 pounds of TNT, with 70,000,000 gallons coming from petroleum and only 30,000,000 gallons from coal carbonization, the normal method of making this principal ingredient of TNT. Toluene from coal carbonization is strictly a by-product, and the yield is only 3 pounds per ton of coal. On the average, selected gasoline fractions yield 50 percent of toluene, with a few giving as much as 80 percent in the laboratory.

Two principal methods, extractive and catalytic, are available for the manufacture of toluene from petroleum. Certain crude oils contain enough toluene so that it can be separated commercially merely by an extension of the basic petroleum refining method, straight distillation or extraction. Much greater yields can be obtained, however, by the chemical conversion or synthesis of toluene from certain gasoline fractions of petroleum. The gasoline molecules obtained by distillation and cracking are further processed to cause a chemical alteration, resulting in toluene.

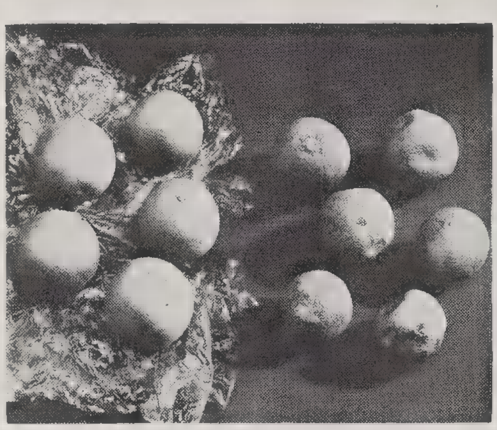
The petroleum fraction used for the catalytic manufacture of toluene is normally a portion of ordinary gasoline. Even doubling the present production so that 200,000,000 gallons of toluene were made from gasoline would have little effect on the supply of motor fuel, he asserted, because this huge amount of toluene, enough to make 2,000,000,000 pounds of TNT, would be less than 1 percent of the annual production of more than 25,000,000,000 gallons of motor fuel.

FRUIT WRAP

Moisture-Proof Film Preserves Fruit

DEVELOPMENT of a new technique in wrapping oranges and other citrus fruits, employing Pliofilm, makes possible the extension of preservation of these important products for months. Tests in the laboratories of the Florida Agricultural experiment station at Gainesville have demonstrated that grapefruit wrapped in this manner and stored at 70 degrees temperature for seven months retained its texture and juices, and seeds showed no indication of sprouting.

Pliofilm, the wrapping material used in the experiments, is a mois-


Plump, wrapped: Shriveled, unwrapped

ture-proof, transparent, synthetic plastic developed in laboratories of Goodyear Tire and Rubber Company, and is widely used for packaging food products.

The success of this application is due to the fact that the wrapping allows transmission of carbon dioxide with enough rapidity to keep the fruit from suffocating, but transmits moisture vapor slowly enough to prevent loss of moisture, thus retaining the juices and fullness of the fruit and preserving vitamin content.

Because thin-gage Pliofilm can be used in a special stretch-wrap process which permits a small sheet of the material to be wrapped tightly around a large surface, application of the new development is feasible from an economic standpoint and also enhances the appearance of the fruit by giving it a glossy surface covering.

RADIO MEN

Thoroughly Trained In Four Months

THOUSANDS of young men between the ages of 17 and 28 are becoming trained radio operators through enlistment in the Naval Reserve.


Receiving position for training

Not only are they obtaining training which will likely prove highly valuable on return to civilian life, but in the meantime they are helping the Navy to meet its urgent need for radio personnel, now a doubly important feature as United States participation in the war gets into gear.

With the concentrated training program developed by the Navy a man, even without previous radio experience, becomes a qualified operator ready for active service at ship or shore stations after only 16 weeks of training. He is then capable of copying code directly on a typewriter at a rate of 25 words per minute, has developed general familiarity with navy transmitters and receivers, has acquired knowledge of the fundamentals of visual and underwater signaling, and has been trained in basic naval subjects and routine.

Every effort is made to keep this training as practical as possible. This is carried even to the extent of providing at the schools groups

of complete receiving positions similar to those encountered in active service. These afford practical experience in tuning regular naval communications channels and copying actual naval dispatches from the air. The accompanying illustration shows one of a number of such receiving positions at the U. S. Naval Reserve Training School, Noroton Heights, Connecticut, each equipped with its own Hallicrafters communications receiver.

The Noroton Heights school alone trains 500 operators every four months and others distributed throughout the country are training thousands each year. These are men selected on the basis of aptitude or previous radio experience from among those enrolled at naval training stations.

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EYES: Although parents with brown eyes may have children with blue eyes, very rarely do two blue-eyed parents have a child with brown eyes, according to the Better Vision Institute.

• • •

PAINT CLEANER

Prepares Old Finished Surface For New Coat

When it becomes necessary to repaint a glossy or enamel coated surface, some means must be provided for deadening the gloss so that the new paint will bond to the surface. With a new material called Imperial Wil-Bond, this job is simplified. Wil-Bond is a clear liquid which is applied with a cloth to remove dust, grease, and wax. It also cuts the gloss from the surface and sets up a slight tack which insures a complete bond with the new paint. If the surface to be refinished is clean and free from grease, the Wil-Bond liquid need merely be added to the new paint before application.

ALL-WHEEL-DRIVE

Replaces Ox-carts in Geological Service

From ox-cart to a modern all-wheel-drive truck is a pretty long jump, but nothing in between could do the job, according to Gordon Barbour, president of the Barvia Company of La Paz, Bolivia.

Marsh buggy for geological operations in Bolivia

Mr. Barbour owns gold and oil properties far back in the interior of Bolivia where the only roads are ox-cart trails over mountain, marsh, and plain. As many as 20 oxen are employed in places to pull a single cart at speeds of 15 to 18 miles per day.

As a result of experience with a previous purchase of a Marmon-Herrington light delivery all-wheel-drive converted Ford, Mr. Barbour was convinced that a similar vehicle with much larger tires and other special features would be exactly what he needed to conduct geological surveys over his properties.

The vehicle finally developed presents a rather weird appearance, but from tests made locally,

• • •

CAR AGE: 43 percent of all the motor vehicles ever sold in United States are still in operation. 74 million cars have been sold up to the end of 1940, and 32 million are still in use.

• • •

there is no question but that it will render the service expected. Starting with a standard ton and a half truck, engineers proceeded with the same conversion to all-wheel-drive which has been done with thousands of similar units for industry and military services. But the change did not stop there. In addition to equipping the truck with a heavy duty winch and air compressor, both operated from a power take-off on the auxiliary transmission, two complete sets of tires were provided. The first set, for operation on paved roads, were 9.00 by 20's all around; while the others were mammoth 13.50 by 24's, dual mounted on the rear wheels, to provide the extreme flotation and traction necessary for the worst imaginable cross-country operation.

BEETLE CONTROL

Possibilities of "Milky Disease" Bacteria

Injecting a tiny helping of "milky disease" bacteria into the body cavity of a Japanese beetle larvae is a ticklish operation. If a fleshy little larva wiggles — and wiggle they will — the intestine may be punctured and the injected inoculum lost.

So United States Department of Agriculture entomologists have discovered a way to take the wiggle out of the larvae during this delicate operation — by anesthetizing them. S. R. Dutky of the Bureau of Entomology and Plant Quarantine has found that larvae may be anesthetized for a period of eight hours with little or no ill effect. He uses dry ice to furnish the carbon dioxide anesthetic.

"Milky disease," natural enemy of the Japanese beetle, is being tested widely by entomologists as a beetle-control measure in heavily infested areas. The bacteria are injected into healthy Jap beetle grubs, where they multiply. Bodies of grubs so injected are ground, mixed with talc, and dusted over the ground or placed in soil where grubs are feeding. A feeding grub takes up the disease germs which reproduce in tremendous numbers until there are enough to kill the grub. Grubs killed by the disease

(*Please turn to page 88*)

LEARN THE EASIEST OF ALL LANGUAGES

Speak SPANISH AT ONCE

FOR BUSINESS OR PLEASURE

Expanding U. S. trade with South America means *new opportunities* if you can speak SPANISH! Today, more than ever before, American firms need SPANISH-SPEAKING export managers, clerks, translators, salesmen, engineers, stenographers, secretaries, business and professional people.

World conditions have made SPANISH the most important foreign language. For business, for culture, travel or pleasure, it is the most useful as well as the easiest of all languages to learn. And now you can learn SPANISH in your spare moments — right in your own home—quickly, easily, cheaply—in only 15 minutes a day!

Learn as a child learns-by listening to native instructors in your own home!

What Others Say

RUDY VALLEE

says . . . "delighted with results from Spanish and French Cortinaphone Courses . . . invaluable in broadcasting and recording."

FRANK LUTHER

says . . . "Pronunciation on records remarkably clear."

"Anyone Can Learn"

"Your clear records make it possible for anyone to learn the language of their choice." — *Mr. Tom White, Muskogee, Okla.*

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"Have just returned from Mexico and found that my Cortinaphone Course was a good investment."— *Phillips B. Iden.*

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"I believe your method the best way to acquire a working knowledge of a foreign language in the shortest time." — *Louis A. Smith, Fort Kent, Maine.*

THE QUICKEST and surest way to learn SPANISH, or *any* language, is by *listening* to it—the way children learn! This is the *natural* way: to listen, then repeat what you hear until speaking the language becomes *natural* to you.

Cortina "Learn by Listening" Records bring the clear, cultured voice of a native SPANISH instructor with easy time-tested Cortina lessons right into your living-room. He talks to you whenever you wish—as often as you like—in faultless, idiomatic Spanish. He converses with you just as any SPANISH-SPEAKING person would, on the streets, in shops, in the offices of a South or Central American city. Your instructor never tires, never complains!

New Opportunities Ahead— Now is the Time to Learn!

SPANISH is the *easiest* of all languages to learn! And *this* is the finest time to learn it. The tremendous expansion of our interests in the Latin American countries will open up excellent opportunities to you for years to come! Practically every day our newspapers announce new trade pacts and the opening of new branch offices in South America by U. S. firms.

Remember, SPANISH means greater social advantages, too. Everyone should know at least one foreign language. With SPANISH, you discover new and interesting cultural fields. And imagine the thrill of being able to stray away from the "beaten paths" of the conducted travel tours—and truly *enjoy* out of the way corners of lands to the south!

You'll be amazed how quickly you can pick up ordinary conversation! Business and commercial terms soon become second nature to you! With Cortina "Learn by Listening" Records, you can progress as fast, or as leisurely, as you wish!

Prove It Yourself— Make This 5-Day Test

With the Cortina Method, you need not spend long hours in class, or pay high fees to an expensive tutor. You start AT ONCE to learn SPANISH *as it should be spoken*—not with an "accent" that can't be understood (the kind people *laugh at* even if they eventually *"guess"* what you mean) but SPANISH that can be understood and really used *wherever you are.*

Today, when SPANISH, the most important foreign language in the world can mean so much financial gain and travel pleasure, why not see what this fascinating, inexpensive Cortinaphone Method will do for you? You risk nothing. You first PROVE—right at home—that this amazing method CAN quickly teach you the language of your choice.

FRENCH, GERMAN, ITALIAN,
Also Taught

Cortinaphone Courses in French, German, Italian and English (for Spanish-speaking people) are as effective in teaching you a new language as the Spanish course described here, and are sent on the same "Proof-in-5-Days" Offer.

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Our Search for the Supernatural

Do Mediums Fear to Face a Scientific Investigation of Psychic Phenomena?

A. D. RATHBONE, IV

Secretary, Scientific American Committee for the Investigation of Psychic Phenomena

It seems fully apparent at this time that most mediums, psychics, and spiritists have no desire to attempt to prove once and for all that there exists a basic, truthful, scientific explanation of their so-called phenomena. Presumably, if the lack of collaboration which our Committee has thus far received in its investigation of psychic matters is any criterion, most producers of psychic demonstrations prefer to continue their activities in their own dimly-lit or darkened mediumistic parlors with their own groups of "believers" without benefit of public acceptance that the things that take place there are factual, and not hoaxes. Indeed, one leader in the psychic world, himself not a medium, has emphatically urged that all persons who claim supernatural power avoid our Committee and its earnest efforts to prove the truth, as though the idea of psychic research were a pestilence.

True, we have had demonstrations, we have had seances, but of none of them can it be said that anything of a startling or outstanding psychic nature presented itself. While we are beholden to those mediums who have come forward in an effort to co-operate for the benefit of the public by conclusively proving the existence, the presence, or the motivation of psychic forces, we must, nevertheless, conclude that the mediumistic world as a whole is fearful of the clear, cold light of a scientific investigation. It has been estimated that upwards of 50 million dollars yearly is paid to mediums, psychics, seers, fortune tellers, and others who claim occult powers by persons who seek answers to the query of what lies ahead, or to establish alleged "contact" with those who have passed on. This is big business, even in these days of fabulous figures, and it may be that there is reason for the lack of co-operation to date.

When, last April, Scientific American joined forces with the Universal Council for Psychic Research in an effort to determine the truth concerning psychic matters, it was emphatically stated "that this proposed inquiry into psychic and spiritistic phenomena in *no* sense questions any form of religious belief, but is solely a scientific study to determine the true facts concerning what have been termed 'supernatural manifestations.' " In other words, this investigation is not a "witch hunt"; it does not seek to belabor, besmirch, or to expose any person or his belief. Rather, it is a conscientious attempt to settle an important question, one which, because of war and unsettled social and economic conditions, has become greatly amplified in the public mind. In times like these, far too many people turn to secret rites of cults or individuals in a desperate venture to satiate their craving for knowledge of the future; they are, unconsciously, perhaps, trying to allay a gnawing fear. This, we have maintained, is an attitude inimical to the national welfare; it is a dangerous trend—*unless* the claims of the psychics and the mediums are true!

If it is possible to contact forces of which we now know nothing, and if those forces can be of assistance to individuals and to the nation in this time of peril, then, by all means, let us know more of them—let us make use of them in this national emergency. If mediums and psychics are, for some thus far unknown reason, persons peculiarly adapted to perform this service to the country, then let us enlist their services at once. *But,* before that action can be taken, they must prove beyond all question of a doubt that the ability they profess to possess to contact the "spirit world" is authentic; that their theories are tenable and truly applicable to the best interests of the public at large.

If the psychic forces do exist, if they can be contacted by specially gifted persons known as mediums who claim that certain physical psychic manifestations are proof of such contact, then beyond a doubt the fears and the worries of thousands of us can be alleviated by further knowledge of the occult. However, just as a man who joins our armed forces must demonstrate his physical and mental capabilities for such service, so must the spiritists, psychics, and other purveyors of mediumistic service prove their fitness to be publicly considered as an authentic source of knowledge of what transpires in another world or of what will transpire in this one. In this respect it is again and again emphasized that these statements do not refer to Spiritualism as a religion, nor to any other form of religious belief, the tenets of which may provide mental and spiritual solace, especially in times of severe trial. We are concerned only with those who, for compensation or otherwise, allege that they can produce psychical manifestations of a physical nature which are in turn interpreted as demonstrations of occult forces, or which are construed so as to give "messages," information, or to prognosticate the future.

The Scientific American Committee for the Investigation of Psychic Phenomena is a body originally constituted and consistently maintained to endeavor to ferret out the truth regarding spiritistic phenomena. To that end, six simple regulations were laid down to govern the activities of the Committee and any persons or organizations who might be willing to co-operate with the Committee, and an award of $15,000 was established through the joint appropriations of Scientific American and the Universal Council for Psychic Research. (April 1941). In regard to the award, criticism has arisen that this is an objectionable feature, but it must not be forgotten that the announcement that a substantial sum is available for the unequivocal proof of what is today unproved is, in itself, evidence to all and sundry of good faith. Further, mediums or others who may join in our search for the supernatural might be put to expense or actual loss by working with us, and deserve remuneration, if and when the psychic premise can be followed with *quod erat demonstrandum.* Again, if

any psychic feels that his or her services would be tainted by acceptance of the award, its donors will gladly make it payable to any charity or other beneficiary, duly and legally appointed.

As for the regulations, they are, as has been pointed out, simple in the extreme. We ask only that formal application in writing be presented to the Committee stating that any phenomena produced by the medium will be "accomplished solely by supernatural, spiritistic, or psychic agencies, and not through trickery, abnormal physical development, legerdemain, or mechanical devices." Certainly, if the medium sincerely believes he or she has psychic powers and has no need to resort to trickery — as many have been shown to do — there can be no objection to this requirement.

Naturally, demonstrations or attempted demonstrations must be performed in the presence of our Committee or such of its members as may be appointed by the Chairman, and, as a corollary, the Committee or its Chairman may request repetition of seances or demonstrations. Most important of all, perhaps, is the regulation that "demonstrators of psychic phenomena will be permitted to name and to work under their own conditions during the first seance or demonstration, so long as such conditions are compatible with the best interests of the aims of the Scientific American Committee." Obviously, the Committee, en toto or in part, cannot today journey to the Philippines, Mexico, or Brazil, as has been suggested by certain correspondents. Nor is it feasible under present conditions to hold Committee meetings here, there, and everywhere, but any medium or psychic who desires to appear before our Committee in New York City or its immediate environs will be welcomed.

IT IS extremely noteworthy that there are *no* test conditions placed on the medium at the first appearance before the Committee. He or she is entitled to demonstrate unmolested and unhampered, despite the fact that in some instances in the past, the mediumistic operations proved immediately to be transparent as fraud to one or more members of the Committee. Furthermore, even if test conditions are imposed at a later seance or demonstration, the Committee agrees "to the best of its ability to see that its conditions do not hinder or inconvenience the medium or demonstrator." As Scientific American is the official publication of the Committee, its publishers reserve the right to present the findings to the public. Finally, it must be remembered that the present investigation does not incorporate telepathy, telepathic experiments, or any other form of mental phenomenon or demonstration.

IN THE past, through the efforts of Scientific American and other investigatory bodies, it has been conclusively proved that certain individuals who termed themselves "mediums" and who claimed to have contact with psychic forces had no such contact and had utilized mechanical appliances or other "human" means to produce their so-called phenomena. These people had accepted money from the public for their "demonstrations." This, however, is not to say that psychic forces do not exist or that they may not be contacted. Somewhere there may be a person or persons who have succeeded in one of man's ever-hopeful ventures—to determine survival after death, to communicate with the spirits of the next world, either or both accomplished with physical rather than mental evidence as proof. If such there be, let him now come forward and work in harmony and in full confidence with the Scientific American Committee for the Investigation of Psychic Phenomena. All that is sought is the truth, the scientific explanation concerning this age-old problem, but unless broader and more generous co-operation can be obtained in the future from the disciples of psychic belief, their silence and failure to co-operate can only be construed as too significant to need further comment.

There can be no doubt that the controversy of today over this question is essentially the controversy of 1000 B.C. translated into modern terms and given an up-to-date setting. It is, perhaps, too much to hope that it may ever be permanently settled, but it does not seem too much to wish for that our Committee may be instrumental in producing conclusions for this generation, conclusions that will be effective at least until this generation grows old and dies off, in favor of another generation with a shorter memory. To that minimum of effect our Committee will continue to bend its efforts.

(*Continued from page 82*)
turn milky white, disintegrate, leaving little heaps of disease germs to be picked up by the next generation of grubs — and so on.

MOBILE POWER

Railway-Car Plants For U. S. Navy

THE Bureau of Yards and Docks, Navy Department, has ordered two 10,000-kilowatt mobile steam-electric power plants mounted on special railway cars from the General Electric Company to supply emergency power wherever its projects may require.

The mobile power plants will be the first of their kind to be built, but the turbine generators, boilers, and electrical equipment used in them will be apparatus of the types proved in service in regular industrial installations.

Each of the units will be housed in two specially built railway cars which can be hauled over the rails at speeds up to 40 miles per hour.

The power-generating car will contain a 10,000-kilowatt turbine-generator and its accessories, a condenser, and the necessary switchgear. The boiler and its auxiliaries, along with a starting engine generating set will be housed in the second car. A mobile sub-station, constructed on a standard car, will be used in conjunction with each generating unit to permit proper voltage to be obtained for any Naval Shore Establishment.

Engineers estimate that the mobile power plants can be put "on the line" within 24 hours after they are shunted into a siding.

Bunker C fuel oil will be used to fire the boilers, and each unit will consume about three tank cars a day when operating at full load. A sufficient fuel supply for two hours' operation will be carried in the boiler cars of each of the units, however, so that they can generate power before the tank cars are hauled up and connected.

COACH-SLEEPER

Features New Economy In Rail Travel

COMFORT and economy for the railroad traveler are the two factors which influenced the design of a new coach-sleeper recently put into experimental use on several railroads by the Pullman Company.

Triple-deck berths

The cars are completely new in design, being provided with a side aisle and a series of compartments. For daytime use these compartments are made up with seats for three passengers in the single units or for six passengers—in groups of three, facing—in the double compartments.

For night use, the compartments are converted into sleeping quarters for three in the single sections and for six in the double sections. Access to the center and upper berths is provided by a sturdy stairway-type ladder which is removed in the daytime set-up of the compartment. Each one of the berths is provided with a reading light and an individual control for air from the general air conditioning system of the car. In each compartment is a wash basin furnishing hot and cold water, a dental faucet, a mirror, and an electric shaving outfit. In addition to these facilities there are two individual wash rooms and a toilet located in each end of the car.

These new cars accommodate 42 passengers in ten single compartments and two double compartments.

Double compartment in new coach sleeper, set-up for daytime use

TIME

To Exact Second With New Wrist Watch

THERE are many spheres of activity, particularly broadcasting, where time to the exact second is necessary. As a matter of fact, there is no timepiece of a portable kind that can keep time to the exact second for any very long period. Furthermore, in a conventional watch, when the stem is pulled out to set the minute and second hands, the action merely disengages them from the movement. The movement continues to run, and the second hand continues to turn. It has not been found practical because of high gear ratio to disengage the second hand from the movement. In a new watch just announced by Longines, however, pulling out the stem not only frees the hour and minute hand, but also stops the watch.

In remote broadcasting, where

programs must be dove-tailed into a schedule controlled by the master station control clock, there is time lost and uncertainty on the part of the man running the remote show because he never knows to the second when he should be ready to go. This new Longines watch can be synchronized with

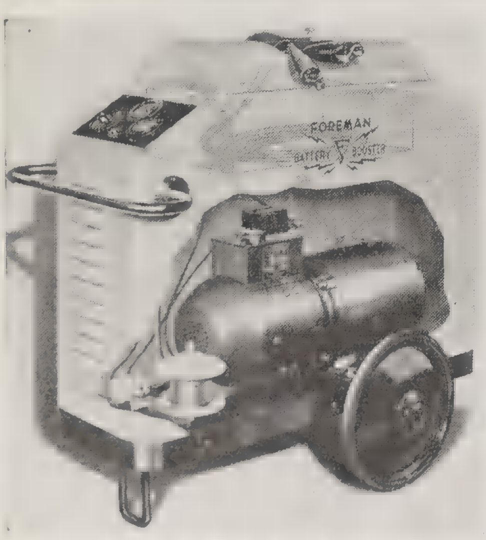
Wrist watch that can be set to exact second

the station control clock before the engineer goes on a remote job, in this way; when the second hand of the watch reaches the "12" position, the stem is pulled out, and the watch stops. The minute and hour hand are then set a minute or so ahead of the time shown on the control clock. When the control clock reaches the time set on the watch, the stem of the watch is pushed in, and the watch starts, synchronized to the precise second with the master clock. The watch is of conventional strap watch size, and under ordinary conditions will remain synchronized with the master clock for several hours, and operations can be carried out exactly as if the station clock was being consulted. Since the watch can be stopped, reset, and started as often as desired, it can also be used as an emergency timing watch.

CHARGER

Portable Unit For Vehicular Batteries

Storage batteries for motor vehicles can be charged without the



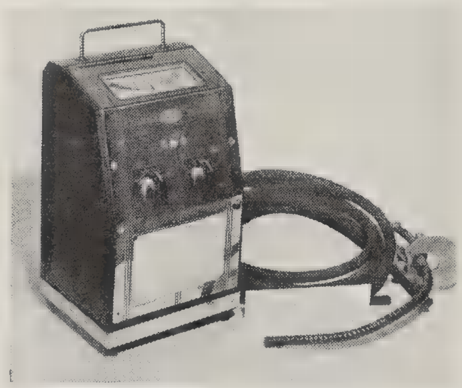
Auto battery charger

necessity of removing the battery by using a new gasoline-driven portable battery-charging unit recently announced by W. D. Foreman. The gasoline engine of the unit is of the air-cooled type and is directly connected to a generator. The latter is provided with the necessary controls and a pair of cables that terminate in battery clips. The complete unit is assembled on a two-wheel truck. A fuel tank, air cleaner, and other essential accessories make it completely self-contained.

FUEL ECONOMY

Stepped Up By Mixture Indicator

In view of the present gasoline situation, all motorists and operators of trucks and busses will be interested in an instrument that makes possible a sharp reduction



Maximum mileage indicator

in fuel consumption by enabling them to secure maximum mileage per gallon of gasoline. This instrument is identical in operating principle to that of the Cambridge Aero-Mixture Indicator which enables pilots of thousands of Canadian, British, and American military planes and air transports to attain maximum cruising range through greater economy in engine performance.

Gasoline ignites only when mixed with air and it is the function of the carburetor of an automotive engine to mix these elements in the proper proportions for combustion. A mixture of 15 pounds of air with one pound of gasoline insures complete combustion. This ideal air-fuel ratio of 15 to 1 is not desired in general practice, even though economical in gasoline consumption, because the gasoline engine does not develop maximum power with such lean mixtures. Maximum power is obtained in the usual automotive engine with an air-fuel ratio of from 13.0 to 13.5 to 1.

Since no great loss of power results when the mixture is over-rich, the tendency is to set carburetors on the rich side—and the owner pays for the gas wasted. It is possible by analysis of the exhaust gas of a motor to accurately determine the composition of the mixture supplied by the carburetor. By the use of the Exhaust Gas Tester as a guide the position of the pointer on the scale of the Tester will show at all times whether or not the proper carburetor setting has been made. This small and compact portable instrument analyzes the exhaust gas while the engine of the vehicle is working either in the garage or on the road. Hookup merely requires one to insert the sampling tube of the tester into the tail pipe of the vehicle and the instrument shows instantly the air-fuel ratio and the corresponding percent completeness of combustion.

• • •

RUBBER—Production of combat airplanes alone requires more than 50 different articles made from natural and synthetic rubbers.

• • •

ROD-LIGHT

Flashlight Combination For Emergency Use

A combination torchlight-flashlight made with a 5¾-inch rod of "Lucite," methyl methacrylate resin, aids police officers directing

One use for the new rod-light

traffic and avoiding dangerous tie-ups, and provides a warning signal for motorists and truckers stalled at night in any kind of weather.

The "Lucite" rod is completely lacquered a brilliant red to give off a bright, penetrating glow, except at the end, which is crystal clear,

emitting a strong ray of light similar to that of a flashlight. The light may be attached to a fender with a suction cap. The plastic rod is reported to have high light transmission, to weigh little, and, furthermore, to be virtually unbreakable.

CHINA STRUCK

Oil Well Drillers Find Pay Dirt

TEXAS oil-well drillers, who've been keeping a weather eye out for China, can relax now. It's been sighted. Researchers, doing a little prospecting on their own, have found it, spelled with a small "c," in abundant supplies of pay dirt, hitherto unknown in Texas—volcanic ash.

From this unique formation, there has been developed china tough enough for Army mess boards and fine enough to grace the governor's banquet table. The new porcelain, three times stronger than ordinary china and of an unequaled snow-whiteness, will tend to relieve the shortage of fine china imports from European countries, it is believed.

PAINT REMOVER

Requires No Washing Of Surface

PAINT, enamel, lacquer, varnish, and shellac can be readily removed from surfaces that must be refinished, by the application of a new paint remover which requires no washing of the surface after use. The remover, known as No-Wash, is a liquid which remains wet after it is applied to the surface to be stripped. No-Wash and the surface coating are then removed with a scraper. No residue is left on the clean surface and hence no further work has to be done before the application of new paint. It is claimed that No-Wash does not raise the grain of the wood or injure veneer.

HOME REPAIRS

Pulverized Patching Material Of Many Uses

AMONG the most trying of household problems is the repair of leaks in roofs, cellars, around chimneys and windows, and many other places. Recently there has appeared on the market a material known as U-Mix-It which is claimed to give the answer to many of these problems. This material has been developed from a formula utilizing pulverized asphalt which has a melting point of over 250 degrees, Fahrenheit; by the use of various solvents it can be converted by the home user into a paint or a variety of putty-like substances.

Mixed with kerosene, gasoline, turpentine, or other solvent it forms a paint which can be brushed or sprayed, or, by combining the pulverized asphalt with sand, cement, asbestos, or other fillers, a weather proofing and sealing compound can be obtained which may be applied with an ordinary putty knife or trowel. It is claimed that the mixed product has extraordinary adhesion for most of the materials to which it will be applied. Besides the repair problems mentioned above, the mixture can be used for preserving wood, for tree surgery, for lining fish pools, and for sealing cracks in tanks, dams, silos and so on. In all uses the material is said to be completely water-proof.

Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

GLUE SPREADER

Industrial Unit Holds Two Quarts

FOR spreading glue on large work surfaces, a new tool known as Glue Gun holds two quarts of liquid adhesive. The liquid is fed

For spreading liquid adhesives

to a head which spreads it to a width of one inch on the work. The head includes a corrugated roll and a doctor bar to insure uniform coverage.

HAND GUARDS

For Protection of Industrial Workers

A PRACTICAL finger guard, or finger stall, combining tough leather and flexible lastex, has recently been designed by the Industrial Gloves Company. This new safeguard is comfortable and durable, gives protection on fingers and thumb, in any combination, to buffers, polishers, sanders, grinders, operators of stamping-out presses, assemblers of small parts, book binders, trimmers, mechanics, and machine operators, both women and men. May be worn *under* glove for extra protection. If worn with leather on back of finger, Steel-Grip finger guard protects knuckles from raps, cuts, abrasions.

Another development by the same company is the new "fingerless" glove which meets the unusual requirements of operators who must have complete freedom of the fingers—"touch" to sort or pick up thin sheets or small parts. Complete protection, however, is provided for the palm of the hand and between thumb and fore finger. In addition to being made of chrome tanned leathers, the glove is steel stitched which eliminates the possibility of ripping. The glove may be worn over the bare hand or over light-weight glove.

HYDRAULIC VISE

Pedal Controlled, Capable Of Heavy Work

PRESSURES up to five tons between jaws, and the possibility of considerable savings in time and labor, are offered by a new hydraulic vice which has been developed by the Studebaker Machine Company.

The new vise is designed to speed up small press and cutting operations, as well as ordinary vise work, and is understood to have wide application on production lines, in tool rooms, and for maintenance work. It is operated entirely by foot control, permitting the use of both hands in setting up and removing work. The unit is self-powering.

Pressure to close the jaws is controlled by a foot-pedal pump arrangement in a pedestal mounted on the floor. The latter is connected with the vise proper by a steel tube which carries the hydraulic fluid to a ram behind the back jaw and thus moves it forward; the front jaw is stationary.

Stepping on one pedal moves the vise jaw to contact against the work while a second pedal applies pressure up to five tons and a third pedal releases the jaw.

Some of the different types of jobs the new hydraulic vise can perform are presswork, punching, bending, cutting, straightening, testing, and stamping. Because the operator can use both hands, exceptionally heavy work can be easily handled with a degree of precision heretofore impossible. Also, due to the pressure exerted, certain special work can be handled, impractical for the ordinary vise.

INSULATION

For Wires Makes for Smaller Motors

THE efficiency of nylon as an insulator permits the manufacture of motors requiring 10 to 15 percent less space than those of equivalent capacity using conventional magnet wire insulation, with a corresponding saving in vital core metals like iron, it is reported by the Du Pont Company.

Motors such as those made for small power tools, fans, vacuum sweepers, refrigerators, pumps, ignition coils, generators, food mixers, voltage regulators, and other household and industrial appliances may incorporate enamel-like nylon insulation.

Nylon coating, it is said, provides insulation resistant to abrasion and cracking, has good dielectric strength, and is not adversely affected by any of the conditions of moisture, temperature, compression, or chemical action which such motors normally encounter.

SOLDERING

Tool With Hinged Tip, Dual Heat Range

A COPPER tip which can be positioned at various angles to the handle is one of the features of a new electric soldering tool made by McKinley-Mockenhaupt Company. This construction also makes it possible to provide access to the heat element merely by removing a knurled cap without

Soldering — at an angle

having to take the tool apart. The point of hinging between the head and handle is so located that the tool remains in comfortable balance regardless of the angle of adjustment.

With this new soldering tool, it is also possible to increase the amount of heat concentration at the tip. By pressing a button in the handle and holding it down, input to the heating element is increased for quick temperature recovery or to assist in maintaining the required temperature on a given job. These tools are available in two sizes. The smaller size is rated at 100 watts at normal heat and 400 watts at fast heat; the larger size consumes 150 and 600 watts.

SPRAY CONTROL

Photo-Electric Cell Speeds Shell Production

AUTOMATIC spray machines with photo-electric cell control are now being produced by the Eclipse Air Brush Company for use in coating the inside and outside of projectile shells in one operation. The shells are placed manually on a turntable and then automatically carried to a position in front of automatic spray guns that coat the outside, while an extension nozzle on another gun comes up to spray the inside. The action of the guns is controlled by the photo-electric cell so that there is no spray unless a shell is in position. It is claimed that this machine will handle 75mm armor-piercing shells at a rate of 500 an hour.

DRILLS

For Hardened Steel, Chilled Castings

A DRILL which will cut hardened steel of any type, temper, or analysis is the latest development of the Black Drill Company. Known as the "hardsteel" drill, this tool has been used successfully on carburized, oil hardened, water hardened, cyanided, and nitrided pieces of high carbon, high chrome, and high-speed steels of every degree of hardness.

Hardsteel drills are made by a secret process. They are designed to drill, ream, countersink, and counterbore, and they will do so without tearing or annealing the steel on which they are used, leav-

ing a smooth, burnished surface within the hole.

They have been used as salvage tools, for drilling holes in dies, tools, and pieces of machinery which have been hardened and cannot successfully be annealed for machining; but their most important uses occur in production. Though hardsteel drills are a new invention, they have already eliminated many expensive grinding and machining operations, and are coming into more general use as production tools.

They have been adapted to a number of unusual uses. They will ream chilled castings without noticeable wear, they will cut manganese steel with ease in spite of its work-hardening qualities, they will drill fired porcelain without chipping or breaking it, they will cut sheets of pure carbon, and they will penetrate baked enamel without cracking it.

They will not draw their own temper in any such difficult jobs, and when they do show wear, they can be ground with ease on an ordinary wheel.

BRUSH

For Cleaning Area Around Rivet Holes

A TINY brush, no bigger than a finger, designed particularly for the aircraft industry but applicable to many other industries, has been developed by the Osborn

It cleans around holes

Manufacturing Company. The little tool, used to clean a small area around rivet holes, bolt holes, and so on, speeds up such work and makes it possible for one man to do the work previously requiring several.

All internal and external metal parts of a plane are coated with

zinc chromate paint. Where a good metal-to-metal bond is required to eliminate hazard of fire or radio interference, due to static discharge, the paint must be removed from around rivet and bolt holes.

When it is realized that there are approximately 1,000,000 rivets and numerous bolted connections in a $50,000 military plane, many of which require a metal-to-metal bond, it isn't surprising that entire crews of men, using older methods, were required to work 24 hours a day preparing surfaces.

An analysis led to development of the new brush. It is a tiny end-brush made of wire and incorporates a special pilot rod to fit into the hole. Tests prove that the brush does not clog, that it does the work better, and that it speeds up the operation tremendously.

PRESS

For Laboratory and Experimental Work

DATA on temperatures, pressures, and required current input can be readily determined during the operation of a new hydraulic press designed for experimental and laboratory work.

This unit press, which includes three electrically heated plates in the pressure-applying section, is

Electrically heated

particularly applicable to pressure molding on a laboratory scale. Operation of the press is simplified; a handwheel adjusts the pressure and a single operating lever controls the press movements. Temperatures as high as 850 degrees, Fahrenheit, can be obtained on the pressure plates.

A complete set of instruments are mounted on a panel, in front

of which is a desk surface on which the operator can make his notes, while keeping constant check on the progress of the work.

WAX

New Synthetic Used in Paints, Polishes

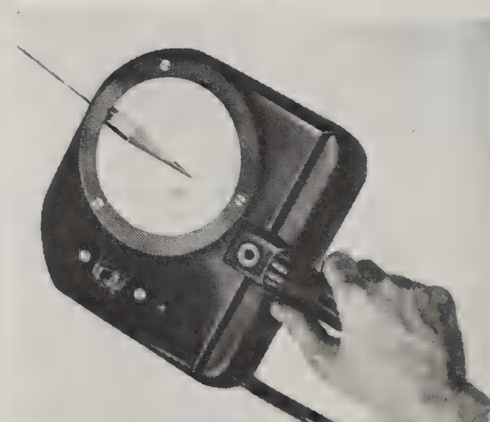
RECOMMENDED as a flatting agent for paints, varnishes, and lacquers, a new synthetic wax made entirely from readily available domestic raw materials has been developed by the Glyco Products Company, Inc. This wax, known as S324, is hard and light colored, and has a melting range of 103 to 106 degrees, Centigrade. It is soluble hot in most oils and hydrocarbon solvents and is soluble in the cold with ethyl acetate.

This new synthetic wax is compatible with most other waxes and with resins. A stock gel can readily be made which can be added to the varnish or to the surface coating as desired without the necessity for expensive grinding operations.

SHIELDED GLASS

Illuminated Magnifier For Inspection

A NEW illuminated magnifying glass, shown in use in one of our illustrations, is being used in a number of industries for inspection purposes. Weighing only 17 ounces, and equipped with a comfortable handle, it can be used almost as easily and flexibly as an ordinary magnifying glass. Lenses available give double and triple magnification. The housing and handle are made of light metal, single or double sockets being provided in the housing for one or two electric lamps. Attached to a corner of the housing is an extension cord and plug leading from a conveniently located toggle switch.



Weighs only 17 ounces

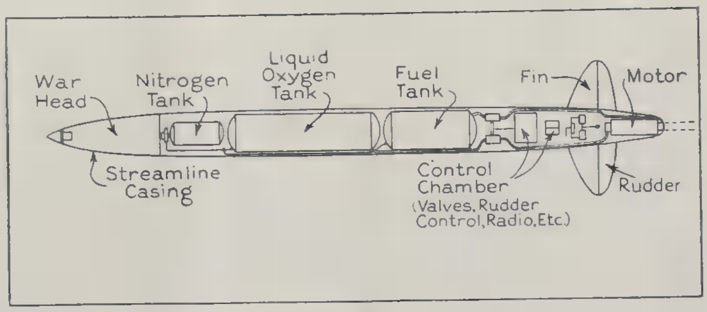
Military Rockets

Anti-Aircraft Traps, Rocket Shells, Weather Study, Airplane Starters, are Possibilities

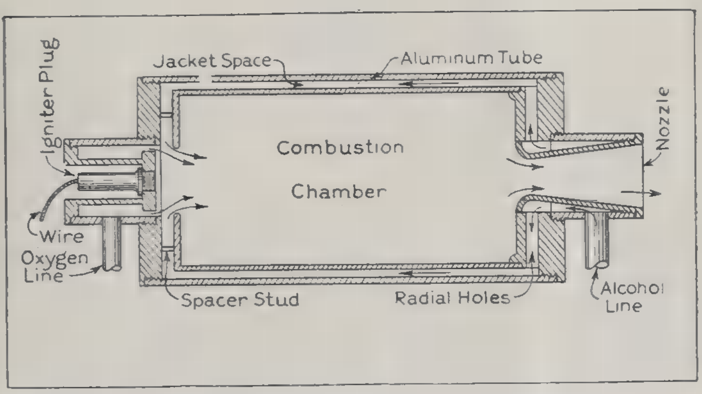
ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

WRITING in the *Military Engineer*, H. Franklin Pierce, President of the American Rocket Society, suggests several war uses of rockets. It is possible to criticize some of the suggestions and some of the methods recommended, but it must be admitted that the article is valuable and thoughtful. In the struggle with aggressor nations, every possible type of weapon should be canvassed.

What would a simple rocket for military use look like? Rocket and



Layout of a military liquid-fuel rocket of the type discussed in the text



Schematic section of a rocket motor, showing combustion chamber, nozzle, ignition arrangement, and so on

motor are schematically illustrated in the diagrams, reproduced by courtesy of the *Military Engineer*. The rocket derives its power from the combustion of alcohol or gasoline in combination with liquid oxygen. The two propellants are carried in separate tanks of simple construction. A third tank carries compressed nitrogen, admitted to the fuel tanks through a suitable regulator, and producing pressure which forces the fuel into the rocket motor through a system of valves and feed lines, at a pressure of about 300 pounds per square inch.

The rocket motor, shown in the second diagram, is merely a combustion chamber provided with a nozzle for the escape of the exhaust gases whose reaction provides the driving force of the motor without the intervention of propeller or other device. Fins at the rear give stability during flight. A control chamber could be equipped for radio reception and wireless control of the rudder and hence of the direction of travel. Nothing very formidable in all this, though a rocket is not cheap as compared with a shell.

Now as to the various possible military uses of rockets:

Today's three-inch anti-aircraft shells are not very effective and do not reach the required altitude. The German bombers were able to reach London again and again in spite of a tremendous concentration of anti-aircraft guns, which were slowly brought into position beforehand and whose fire was tremendously expensive. Rockets, "fired" from a light launching rack would be more mobile, they could reach great altitudes, and they could carry aloft trapping devices such as a wire mesh provided with parachutes. A rocket barrage with parachute-supported wires would be a formidable obstacle.

A rocket starts from the ground with zero velocity and accelerates

as long as its fuel lasts. After the fuel is used up it behaves like a shell. Thus a rocket could readily be designed to reach 30,000 or even 40,000 feet. Perhaps there is here a formidable weapon against enemy bombers? The author recalls that the rocket played a part in destroying Napoleon's invasion fleet against England. Perhaps large rocket shells could become a species of long distance artillery?

Another application of the rocket which has received much attention is its use in weather prediction. A rocket of the liquid fuel type could carry a radiometeorograph, rise to altitude more rapidly than a sounding balloon, and would return for refueling with the aid of a parachute. Another advantage of a rocket over a sounding balloon would lie in more ready recovery of the apparatus.

Finally, the rocket, inefficient as it is for propulsion at the present speeds of the airplane, could be used to give an enormous thrust to planes at take-off and thus permit our long distance bombers to be greatly overloaded.

There are many difficulties, and space will not permit their lengthy discussion. Yet it must be admitted that these are not idle visions but serious, well thought out, plausible suggestions which deserve to be carefully considered by our military authorities.

FLYING BOAT

Could Fly Non-Stop to Europe and Return

In 1910, Glenn L. Martin flew a rickety looking single float seaplane in the first extended overwater flight from the California mainland to Catalina Island and back. More than 30 years later, Ken Ebel, Glenn Martin's chief engineer tested the world's largest flying boat.

Mr. Ebel is one of those rare persons who combine the talents of a designing engineer with the skill of the best and most scientific pilot. His ability to gage the results of his own design work is of inestimable value to the aviation world.

The new ship, the XPB2M-1, is powered with four Wright Cyclone engines of 2000 horsepower each, and can fly non-stop to Europe and back and drop a sizable load of bombs somewhere on the way. It has a span of 170 feet, an interior as large as a 16-room house, and carries a crew of 11 men with assignments to such duties as navigation, piloting, radio, and gunnery. Its weight is 140,000 pounds which is second only to that of the latest Douglas bomber, the B-19.

The great patrol bomber behaved beautifully on its first flights. The photograph indicates the clean lines of the hull. Marked chine lines have disappeared in the effort to reduce air drag and the straight sides of the hull blend nicely into the high wing. No tip floats are visible; presumably they have been retracted into the wing. —*A. K.*

Despite the recent trial-flight accident to the XPB2M-1, this ship, also known as the "Mars," bids fair to take its place among the world's finest. The fact that the ship, with one engine aflame, was quickly brought under control and safely landed; the further fact that members of the crew were able to crawl into the damaged wing and extinguish the fire, indicate superior design.—Ed.

SKYFARER

Only Two Controls, Plus Tricycle Nose Gear

A RECENT and interesting addition to the ranks of light planes is the Skyfarer. By skilful utilization of aerodynamic principles, the Skyfarer achieves a large degree of immunity to the stall and the spin. In fact, it is placarded as incapable

The Martin XPB2M-1 — 8000 horsepower

An interesting light plane, the Skyfarer

of spinning, but that is too much to hope for under every conceivable circumstance. Let us say, rather, that the risk of a spin is very much reduced.

In small planes, flaps are not as a rule incorporated, yet the Skyfarer has them, and the designers were perfectly right in using for a light plane an accessory which has proved itself so useful in larger machines. The rudder is eliminated, so that there is one less flying control, and the student has only to use a wheel, back and forth for elevator control, turning for steering just as in an automobile.

The ability to operate on two controls, thus making it easier to learn to fly, is achieved in somewhat the following manner: The plane is banked with the ailerons in the usual manner, whereupon it side-slips towards the lower side. The wind strikes the over-size tail surfaces from one side, and the plane automatically goes into a turn. Of course, the two-control system, which has been known for many years, has disadvantages to balance its simplification. A plane using this system has not quite the maneuverability of the three-control airplane. Also, there are times when the pilot would not only like a rudder, but would also like a powerful emergency rudder if he could get one.

The General Aircraft Corporation is to be congratulated on adding still another valuable feature to the Skyfarer, as a rule found only on larger machines—namely, the tricycle nose gear. With the tricycle nose wheel, landing in a side wind loses much of its terror. The machine may land side-wise, but the front wheel immediately castors into the direction of motion, so that the plane is soon running quite normally along the ground. All tendency to "ground loop" is thus avoided.

The Skyfarer is very roomy, and exceptionally well equipped for a low-power plane. There again we are fully in accord. The low-power plane should be just as comfortable, just as well equipped as is the low priced automobile, with brakes, hydraulic shock-absorbing struts, a full line of instruments, and so on.

With two occupants, a 75 horsepower Lycoming engine and enough gas for a long trip, the top speed is 100 miles per hour. With flaps down, the landing speed is only 45 miles an hour. There is provision for 40 pounds of baggage and 20 gallons of gasoline.—*A. K.*

LIGHT PLANES

Can be Useful in National Defense

When the war ends, we shall see an enormous increase in private flying, with many of the Army and Navy pilots clamoring for small planes to continue what will become their avocation. But is there any reason why we should be pessimistic regarding the small plane even under the present conditions? Not at all. The private plane owners can render real service in completing our national defenses, by reconnaissance, by ability to fly quickly anywhere to render aid, and in a dozen ways supplementing our more official defense system. And the light planes have shown real possibilities in Army maneuvers in Tennessee. Taylorcraft, Piper and Aeronca companies donated light

planes for these maneuvers, and their performance convinced the War Department fully of their utility. The requirements and achievements of these light planes, from an Army point of view, is that they shall be capable of short-range liaison flights, approach the hovering speed of the autogiro, and have ability to land in and take off from extremely small spaces. Flaps and slots are utilized to the fullest. The machines are generally two-seaters with a 65 horsepower, four-cylinder engine as the power plant.—*A. K.*

RESCUE LAUNCHES

Patrol the Sea for Fallen Airmen

THE R.A.F. has a small navy of its own in the form of rescue launches, constantly cruising the sea, even in the worst weather, and ever on the alert for airmen who have dropped into the ocean. These 53-foot long launches are propelled by three Napier aero-engines of 500 horsepower each and have a top speed of 40 miles per hour, a cruising speed of 32 miles per hour. At maximum speed they have an endurance of 12 hours (sufficient to cover about 500 miles), but their cruising range is considerably greater.

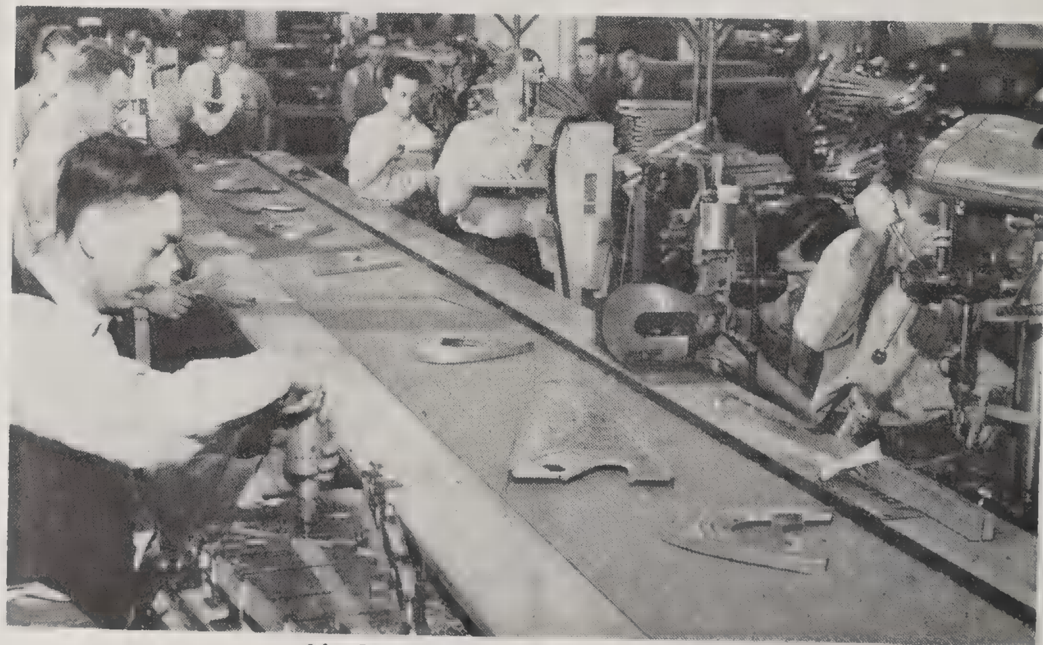
Because these launches are frequently attacked by German aircraft, they carry defensive machine guns, and rescue crews have often drifted helplessly for hours in heavy seas after their engines had been damaged by German fire. Sometimes this miniature navy operates in waves 30 feet high, when they can only see a few yards ahead. Aircraft help them to spot drifting airmen and a criss-cross pattern system is used for final location. These fast craft carry first-aid outfits, life belts, restoratives, and have to navigate very carefully at times to avoid mine fields.—*A. K.*

ASSEMBLY LINE

Speeds Up Production of Airplane Parts

ONCE upon a time the aircraft mechanic was a romantic person who, with three or four others, built a rickety craft which carried the leader of the small crew aloft on perilous and fame-capturing flights. Now the Glenn L. Martin Company has installed the belt-conveyor line shown in one of our photographs. Of course, time is saved, less skilled men find employment, and the weapons against aggression come faster. But gone will be much of the romance.

Here is how the new method of making certain sub-assemblies operates: "Two or more assembly-men at the head of the belt pace the line. Before them are jigs in which the pre-formed or pre-shaped pieces are fitted together and the first drilling operations performed, vari-colored patterns telling instantly the size of the drill to be used. The pieces are then laid on a belt and the drill-pressman picks them up, drills the various holes. Farther along the riveting machine operators fit certain pieces together and rivet them. Another man burrs the rivets. Still farther along other workers fit parts of the sub-assembly together, and finish the job. — *A. K.*



Airplane parts on an assembly line

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Kodacolor Prints

COLOR snapshots even with a box camera, the long-awaited boon for the amateur with modest equipment, are here at last through the medium of Kodacolor roll film, a new color product just announced by the Eastman Kodak Company. Made public by Dr. C. E. K. Mees, the company's Director of Research and Development, the new process is hailed as "the greatest achievement in photography since George Eastman pioneered and introduced the first black-and-white roll film in 1889."

Kodacolor is a complete new process and is not to be confused either with the recently announced Kodak Minicolor prints from 35mm and Bantam size Kodachromes, or with the now obsolete process called Kodacolor which was introduced some years ago by Kodak for an entirely different additive process of color photography used for amateur color movies.

Designed especially for the millions of Marys, Janes, and Johns in this country who have been waiting ever since photography was a pup to see their prints in color rather than black-and-white, Kodacolor is available in six standard camera sizes, exposures numbered 1 to 6, with supplementary numbers for "split-frame" cameras. These sizes include: 120 (2¼ by 3¼ inches); 620 (2¼ by 3¼ inches); 116 (2½ by 4¼ inches); 616 (2½ by 4¼ inches); 122 (3¼ by 5½ inches), and 127 (1⅝ by 2½ inches). Price per negative varies with size from 20 to 40 cents each. Prints are 40 cents each in any size.

Literally, picture-making with Kodacolor roll film amounts to snapshots in color because, just as with ordinary black-and-white film, the amateur exposes his film as usual in any ordinary camera and receives in return, as with black and white, negatives and prints. The only difference, aside from that of price, is that the prints are in full natural color instead of black-and-white. As with black-and-white negatives, inspection of the color negatives will show light areas of the subject as dark and vice-versa. In addition, the negative will contain colors, not the true colors that will appear in the final print, but colors complementary to those in the actual subject. A red sweater, for example, will be blue-green in the color negative.

Kodacolor has a rather fast emulsion speed, about Weston 20, which makes it adequate for use with box cameras in good sunlight as well as for relatively rapid action at large stops when using faster lenses. The basic exposure in good sunlight for average subjects, Eastman reports, is *f*/8 to *f*/11 at 1/50 of a second.

As with Kodachrome and Minicolor prints, exposed rolls of Kodacolor film must be sent to the Eastman plant in Rochester, through dealers and photofinishers, for processing and printing. Negatives to be printed are either selected by the customer after being returned or the choice of negatives suitable for printing is left to the judgment of the company.

The size of the final print is fixed at 2⅞ inches wide. Since the negatives are smaller than this, in most instances, this will mean a slight enlargement, except in the case of the 3¼-inch width of the 122 size, which will be slightly reduced to conform. The length in all cases will, of course, be proportionate to the enlarged width.

In explaining Kodacolor, Eastman gives the following technical data:

"Processes of color photography involve invariably the preparation of three pictures, each taken by one of the primary colors—red, green and blue-violet—and then their recombination to form the final color picture. In the Kodachrome process, the three pictures are taken one over the other on three layers of emulsion. The film is coated four times. The bottom layer is sensitive to red light and registers the red picture; the layer above is sensitive to green light; the top layer is sensitive to blue light, and a yellow filter is placed between the top layer and the two lower layers, so as to protect them from the blue light.

"After the film is exposed, the images of the three layers are developed, and then these images are converted into positives produced in dye by what is known as the 'coupler' process of development. The dyes are put in one after another by three successive treatments with developing solutions containing the proper couplers, so that when the film is finished, the bottom layer, in which the picture was taken by red light, contains an image formed in blue-green dye; the middle layer contains an image form in magenta dye, this being the color which is complementary to green; and the top layer contains an image in yellow dye, yellow being complementary to blue. In this way, a color picture is obtained.

"Some years ago, the Kodak Research Laboratories conceived the idea of working out another process in which the couplers are contained in the emulsion layers, not dissolved in the gelatin layer itself, but dissolved in very small particles of organic materials which protect them from the gelatin and, at the same

time, protect the silver bromide from any interaction with the couplers. In this manner, the couplers are held out of contact with the silver bromide until the film is immersed in the developer. Then the oxidized developer penetrates the particles and there reacts with the coupler and forms the dye inside the particles suspended in the emulsion. This process has now been perfected and introduced to the public under the name of Kodacolor.

"The new Kodacolor process, however, differs very markedly from Kodachrome although it is essentially of the same character. The film is coated with the three light-sensitive layers as well as a yellow filter layer. In each of the emulsion layers are suspended microscopically small particles of organic compounds insoluble in water, and these particles contain the couplers required to produce the dye appropriate to each layer when they react with the oxidized developer. After exposure, the film is processed with a developer of which the oxidation product will react simultaneously with all three couplers and thus produce a dye image along with the silver image in each layer. After the silver has been removed, a negative is obtained composed of dyes in which the image is not only negative as regards light and shade but in which all the colors are complementary to those of the original subject."

Dog Photographer

An old cotton blanket for a background, simple lighting, and a 35mm camera to make many exposures in quick succession, if necessary, is all the equipment Arthur S. Mawhinney, F.R.P.S., uses to make the dog portraits which have now made him famous. A selection of 70 of his portraits of famous dog champions of the larger breeds was recently hung in the American Museum of Natural History in New York, under the auspices of the Oval Table Society of New York.

Stingo of Shotten of Greenfair

A characteristic Mawhinney dog portrait is reproduced, the result of patient assistance on the part of Mrs. Mawhinney, who has the sometimes difficult task of posing the dogs. We are told that it sometimes takes as much as an hour or longer to get the attitude and expression the Mawhinneys want.

Mr. and Mrs. Mawhinney have traveled more than 5000 miles to photograph champion dogs in shows and kennels and the prints represent breeds from every part of the world except India.

Synthetic Snow

Corn flakes were used by Castle Films in a recent 16mm movie, made for amateur projection, to

Snow on the Window

simulate the appearance of snow. The effect looked realistic and completely convincing. The reproduction shows one scene from the movie in which the stunt was employed.

Our Contest

A complete report of the results of the Sixth Annual Scientific American Photography Contest will be found on page 104 of this number. Although a total of 36 prizes, valued at over $1100, was awarded, space limitations do not permit us to reproduce all of the winning pictures. Thus we are presenting only the first-prize pictures in the three divisions. Names of the successful contestants, however, together with their geographical distribution, are given on the page mentioned above.

Color Cartoons

Owners of 8mm and 16mm motion picture projectors may now purchase color cartoon films for home projection, according to an announcement by Castle Films. The company announces "the successful reduction and duplication of color prints for the first time for home movie fans."

Costing no more than the price of unexposed color movie film, the new

films bring to home screens the variety and added interest of commercial color fun cartoons produced in Hollywood, reduced for home projection. The first subjects include "Jack Frost," "Aladdin's Lamp," "Old Mother Hubbard," "The Pincushion Man," "The King's Tailor," and "Mary's Little Lamb."

Films Train Defense Machinists

"CUTTING a Spur Gear," a 16mm sound movie film showing "the *what* of machine tool use, so a man can give his whole attention to the *how*," and prepared under the direction of the United States Office of Education as the first of a series of more than 50 machinist and industrial training films, is now available to industries, schools, and other organizations.

The film library channels of the Bell & Howell Company, Chicago, are being devoted to the loan and sale of copies, the company announces.

Lighting Problem Solved

A NEW YORK CITY commercial photographer, John Muller, called upon to make a photograph for reproduction purposes of a new spotlight (the Fresnel Photospot described in What's New, this issue),

No retouching

achieved the fine result here shown by means of light exclusively and without the help of the retouching artist. The difficulty with this type of photograph is in the illumination of the black exterior so that it can be properly reproduced, at the same time illuminating the lens without burning up the carved details of the Fresnel pattern.

For this particular job, six lights were used in all—three floods and three spots. One spot was directed on the background to create a small circle of light sufficiently large to surround the subject and provide the necessary separation from the background. Other lights were placed in front and in back of the subject. For the inside of the lamp itself, the regular projection bulb was removed and a projection bulb of the "built-in" reflector type (half-silvered) was used instead, with the silvered part turned around to face the reflector. The rest of the housing interior was covered with white paper. The illumination from the silvered lamp therefore struck the reflector first and was then diffused throughout the housing by the white paper lining, giving the desired non-directional result that illuminated the Fresnel lens softly and evenly.

Report on Pictorialism

IN PREPARING its annual report on pictorial exhibitions for the year July 1, 1940, to June 30, 1941, the 56th volume of the American Annual of Photography (1942), shows a perceptible drop in the number of exhibitors. For the tabulated year, the total number of exhibitors came to 7560, compared with 8928 for the year 1939-1940, and 13,746 for the year 1938-1939. Eleanor Parke Custis was found to have been the most prolific of all exhibitors during the period, with 146 prints shown in 55 salons. Frank R. Fraprie, who exhibited 118 prints in 54 salons, came second. Dr. Max Thorek was declared to be the most prolific exhibitor of the past five years, having shown 1053 prints in 317 salons. The highest rating of all exhibitors for the year went to Leonard Misonne, of Belgium. Harvey A. Falk, of New York City, took second place.

Uses for Glycerine

AIR bells on films during development may be eliminated by adding 1/5cc. of glycerine to each liter of solution, according to "Glycerine Facts," publication of the Glycerine Producers' Association. Another suggestion is the following formula for a print varnish, which lends brilliance and durability and is especially suitable for use on bromide prints:

Borax	30 grains
Pale shellac	60 grains
Sodium carbonate	10 grains
Glycerine	30 minims
Water	1 ounce
Boil and allow to cool, then add:	
Alcohol	1 ounce

Add a small quantity of whiting or powdered punice to precipitate the gum wax. Shake well at intervals and allow to stand for several days. Decant and filter the clear liquid. Bottle until needed.

Club Program Planning

ALL work and no play makes camera-club membership a dull thing, is evidently the thesis serving as the basis of Agfa-Ansco's "Report of a Survey on Camera Club Program Planning," which the company offers gratis to all camera clubs. The programs, based on information gathered from 1300 leading camera clubs in the United States, are divided into infor-

WINNING PICTURES in Scientific American's 6th Annual Photography Contest

"AN OUTSTANDING exhibit of amateur photography." "The best display of its kind ever brought together." "The amateurs whose work was entered in this contest out-do the professionals at their own game." These and similar comments were voiced by those who viewed the exhibit of photographs from which the judges selected the final prize winners in the Sixth Annual Scientific American Photography Contest. These winners can take justifiable pride in their success, since they were up against stiff competition.

Space permits reproducing only the three first prize winners and a list of the names of the others who earned awards. Needless to say, the reproductions do not do full justice to the originals, yet so fine was the photographic quality of them that it is retained to a great degree even when the pictures are greatly reduced in size.


First Prize—Division I

Division I

First Prize: **Dr. Irving B. Ellis**
Piedmont, California

Second Prize: **Edward Canby**
Dayton, Ohio

Third Prize: **W. J. Harvey**
Hollywood, California

Fourth Prize: **Truman B. Gordon**
Oil City, Pennsylvania

Fifth Prize: **Mrs. Eldean Olsen**
Santa Monica, California

Sixth Prize: **A. J. O. Romero**
Bronx, New York

Seventh Prize: **Arthur VanVictor**
Detroit, Michigan

Honorable Mention

Henry M. Blatner
Albany, New York

Burnis McCloud
Denver, Colorado

Arthur E. Haug
Chicago, Illinois

Mrs. Eugene Landess
Fayetteville, Tennessee

William Dennin
Chicago, Illinois

Division II

First Prize: **Robert Desme**
Brooklyn, New York

Second Prize: **James Jenkins**
Arcadia, California

Third Prize: **Janet Weston**
Atlanta, Georgia

Fourth Prize: **Mrs. Allen L. Sutter**
San Francisco, California

Fifth Prize: **John Hansen**
Brooklyn, New York

Sixth Prize: **Dr. I. K. Moorhouse**
Beaumont, Texas

Seventh Prize: **Edward L. Gockeler**
Saranac Lake, New York

Honorable Mention

J. P. Whiskeman, Jr.
Van Nuys, California

W. Brooks Hamilton
Lexington, Kentucky

B. W. Leroy
Portland, Oregon

Tom Peterson
El Paso, Texas

Thomas O. Sheckell
East Orange, New Jersey

Division III

First Prize: **L. C. Sefing**
Allentown, Pennsylvania

Second Prize: **Allen L. Sutter**
San Francisco, California

Third Prize: **Tyrus T. Tanimoto**
Honolulu, T. H.

Fourth Prize: **La Vern Frost**
Crystal, Michigan

Fifth Prize: **Harold B. Stoddard**
Westfield, New Jersey

Sixth Prize: **Charles Brennen**
Trenton, New Jersey

Seventh Prize: **Dr. S. A. Bobrov**
Ossining, New York

Honorable Mention

Elmer L. Onstott
St. Louis, Missouri

Hilda Ferguson Hampfler
Kennett Square, Pennsylvania

Charles H. Mundorf
New York, New York

C. W. Mattison
Camp Hill, Pennsylvania

C. Chester Lasell
Oneonta, New York


First Prize—Division II

First Prize—Division III


mal and formal programs, the former participated in by all members, the latter conducted by a single person or small group. The report includes detailed plans and suggestions for more than 40 ideas that have been tested and found successful.

In its survey, the company found that membership ranged from a group of three or four all the way to 20,000, the latter claimed by KYW Camera Club. The Railroad Camera Club, with a membership of 12,000, and the Kodak Camera Club, with 2064, came next in the list. In all it was found there are more than 5000 camera clubs in the country, the bulk of the clubs having a membership averaging 25 to 50 members.

Cork Efficiency

A CORK can be a useful article only if it is properly handled. If you have had trouble getting a cork to stay firmly in a bottle neck, try soaking the cork in melted paraffin. You will find the cork will then fit better and last longer.

Club Auction

THE problem of surplus equipment owned by its members was recently solved by a local camera club by inaugurating the idea of periodic auctions. At these sessions, the members bring in whatever equipment they find they no longer have any use for, and the items are sold to the highest bidder. Outsiders are invited to participate. The result has proved generally satisfactory to both seller and buyer.

"Repair That Camera"

TO MAKE the most of what you have, in view of national defense demands, the Eastman Kodak Company is urging a "Repair That Camera" campaign for American photographers.

"There are 19,000,000 cameras in active use in the United States, and there are probably more than 5,000,000 others on shelves, in closets and bureau drawers," a Kodak executive states. "Although there may be a shortage in some types of cameras, there's no reason why these older units cannot be brought back into service and put to practical use."

A 25-percent reduction in repair costs on all Kodaks during the months of January, February and March, is announced by the company to start things going.

• • •

WHAT'S NEW

In Photographic Equipment

FRESNEL PHOTOSPOT ($12.98; standard 500-watt projection lamp, $1.98 extra): Designed for spot, flood, and combined effects, with bulbs available for black-and-white and color photography. Features: focuses 1-foot diameter spot to 6-foot diameter flood at five feet, projects intense, soft edge beam without lines or color fringes; takes 300, 500, and 750-watt projection bulbs, long-life (500-hour) 500 watt bulb, and special 500-watt 3200° Kelvin lamp for Kodachrome; provides full control of shadow edge, soft to sharp; all-steel welded body; ample ventilation for any burning position; six-inch diameter heat resisting Fresnel lens; 4½-inch chrome reflector; heat-insulating Bakelite handles; may be mounted on tripod; 10-foot cord, switch, and plug; dimensions (on base): 8 inches wide, 10 inches long, 11 inches high; weighs 9 pounds. Various accessories, including light stands, masks, special color kit for color control, light stand adapters, and so on.

EXTENSION FLASH HOLDER FOR KODAK SENIOR SYNCHRONIZER, MODEL E ($14.55): Equipped with rubber insulated cord for extension to 20 feet from camera. Similar to battery case, equipped with ball joint and clamping bracket having rubber pads. Flash bulbs may be operated from release of synchronizer or extension holder.

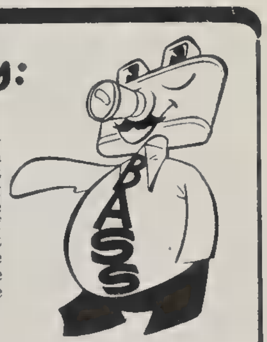
WESTINGHOUSE LAMP DISCOUNTS: Fifteen percent cut from list price on purchase of carton of any one of 17 Westinghouse Mazda photoflash or photoflood lamps. Midget bulbs cut from 13 to 11 cents each when bought in cartons of six.

WABASH INFRA-RED HEAT LAMP ($2): For darkroom and studio use. Color pigmented into glass. Action of rays starts drying process of film and paper from inside out. Made in 250-watt size, natural ruby glass, with burning life of 6000 hours. Suggested uses: speed drying of ferrotyped prints or prints on blotters; quick drying of single films or roll film; heating solutions; drying tanks, reels, and so on.

CRAIG FIRE-STONE WATER FILTER ($3.75): Operates regardless of power or water pressure. Has two fittings to accommodate all faucets. Extra filtering stone. Metal parts triple chrome-plated to guard against corrosion. Maximum flow of two gallons per minute.

KODAK DENSIGUIDE ($1): Compact calculator for estimating gray scale densities on suitably prepared negatives. Especially useful in making color separation negatives and color prints.

NEW WESTON RATING BOOK (10 cents): More permanent form includes 16 pages, 2½ by 3½ inches, printed in two colors and bound with laminated finished stock.



A Monthly Department for the Amateur Telescope Maker

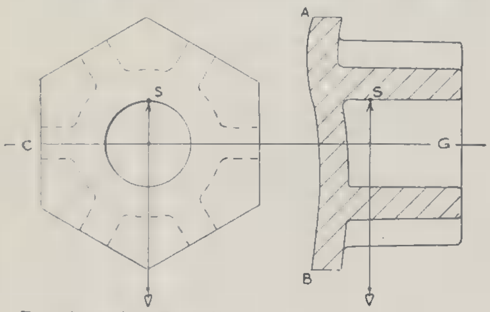
Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced."

LAST month, in this department, Dr. J. A. Anderson, physicist at the Mount Wilson Observatory and Executive Officer for the 200" mirror now being completed at the California Institute of Technology, began a two-part article describing the work of the past five years on the mirror. This month he completes the description. This is the first detailed technical revelation of the difficulties that have arisen in the long years of work on the big Pyrex disk, and of the methods used in defeating them.

Three years ago this department urged Dr. Anderson to describe what was going on, also to state when the work would be finished. He wisely replied: "Dates I can not give yet," and he added, "I shall refuse to describe a job until it is completed, but you may be sure that my article will be in your hands within ten days of the completion of any one stage."

This promise was kept recently when the stage of bringing the surface to a sphere, preparatory to parabolizing and figuring, was completed. The account proves to be something of a now-it-can-be-told story, for there were troubles. Yet anyone who has ever made even a small telescope mirror could have predicted this — there always are troubles, some of them almost interminable; while in pioneering a mirror of unprecedented size, such as the 200", they were all the more expectable. Those that were encountered now turn out to have been even more puzzling than the best of the tales circulated orally by "Old General Rumor." Yet they were conquered and the project moves successfully toward completion — when? This still is unknowable — for a telescope mirror is finished when it is finished. Dr. Anderson's account, continued from last month, follows:



Drawings by Russell W. Porter

Figure 5: **Theoretical hexagon**

"Optical tests of the 200" mirror were at first made with the mirror tipped up so its optic axis was horizontal, using therefore only the one component of the supporting levers. Later on, tests were made with the axis pointing about 4° above the horizon, so that both components of supporting force would be in action. In the later stages of figuring the mirror was made to rest on the supporting system while polishing was in progress.

"The first optical test of the mirror, in September 1938, revealed a fair spherical surface with some zonal and other errors, the chief of which was astigmatism. Measurement of the latter showed that the radius of curvature of a vertical plane was a millimeter or so shorter than that of a horizontal section. Rotation of the mirror about its axis in the testing position showed that the astigmatism did not rotate with it — in other words the radius of curvature in the vertical plane remained shorter in all positions of the mirror.

"More refined measures revealed another surprising fact — namely, that at times the vertical astigmatism would have slightly different values in two orientations 180° apart. Running down the cause of this behavior required considerable time after it had been demonstrated to our satisfaction that the phenomena were real and not simply errors of measurement. A linear astigmatism of the order of 0.05", with a not very smooth mirror surface where errors of measurements would average 0.01" or 0.02", does not seem so very bad — and the 180° effect of about 0.01" might very well be considered accidental — as it was in fact until continued improvement in the figure reduced errors of setting to a few thousands of an inch. Anyway, both of these effects which had been noted in the early tests turned out to be real and correctable, though it must be confessed that it took a year or more to discover their nature and cause.

"The cause of the vertical astigmatism lies in the structure of the mirror itself, combined, of course, with the method of internal support. Suppose the mirror is tipped up so that its axis is horizontal. Its weight then is carried by the 36 levers whose points of contact are in the rib structure and something like four or five inches behind the continuous front of the mirror. Let us think of one of the hexagons (Figure 5), into which we divided the mirror in the previous discussion, as made up of two parts: first, the solid front curved plate and second, the ribs. The front plate is about twice as stiff in a vertical plane as the rib system is.

"If now the support point were located at the center of gravity (actually, on the axis of the 'pocket'), the half of our unit below the center of gravity would be in tension, so that it would stretch; while the part above would be in compression. Also, the deformation of the ribbed part would be twice as great as that of the solid front. If the undeformed front surface were a plane, it would, under this deformation, become slightly S-shaped vertically; that is, the upper half would be slightly convex, the lower slightly concave. Since, instead of a plane, we have a spherical surface in the undeformed condition, the deformed condition will consist in the addition of a very weak convex cylinder to the upper half and a similar concave cylinder to the lower half of the unit. Taking now the whole mirror, each of the 36 parts would be similarly deformed, but there would be no general deformation of the surface as a whole.

"Return now to the actual case. See Figure 5. The supporting point is on the upper surface of the 'pocket', which lies some 6" or 6½" above the center of gravity. The part *A* that becomes convex is therefore 6" shorter than the lower part near *B*, which becomes concave. So we may say that, on the whole, the unit is concave; and when we now add up the 36 parts we find, in addition to the local deformation of each unit, a general (net) vertical concavity of the whole surface, which is what has been observed. The diagrams of Figure 5 will perhaps aid in under-

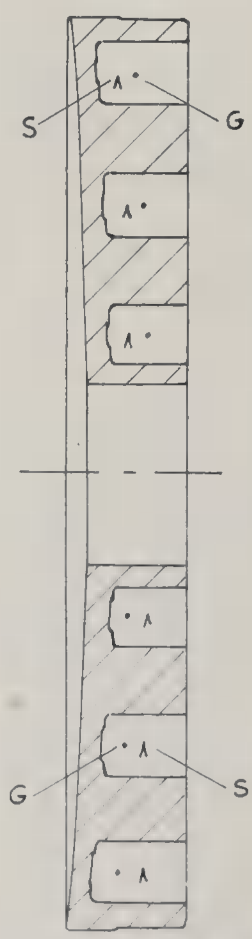


Figure 6: **Cause of astigmatism**

standing this. The local deformations of each unit are of course present, but they are so very much smaller than the net deformation that, provided the latter is small, the former will be too small to be observed.

"If, in Figure 5, the support *S* could be located on line *CG*, curve *AB* would be symmetrical about *CG*, and the net curvature of *AB* would be zero.

"Clearly the effect just discussed will be absent, or have zero value, when the axis of the mirror is vertical. As the mirror axis is tilted toward the horizon, the effect will vary as the sine of the zenith distance. To correct it, a system of 12 gravity-operated 'squeeze levers' were applied, acting on the outer edge of the disk near the back, which, when the axis of the mirror is horizontal, act so as to correct the error. Since their effect also varies as the sine of the zenith distance, the compensation will be correct in all positions of the axis.

"The second phenomonen mentioned above—that is, vertical astigmatism in two orientations 180° apart—is caused by a maladjustment of the supporting levers, and, like the one just discussed, is absent when the mirror faces the zenith. Let us again consider the mirror tipped up, with axis horizontal, and assume that the supporting levers such as *S*, Figure 6, in the upper half are on the average so adjusted that their supporting points are somewhat in front of the center of gravity surface in the mirror, while those of the lower half are misplaced in the opposite direction. Reference to the same figure will make it clear that, in the assumed position, the radius of curvature in the vertical plane will be lengthened, while if the mirror is rotated 180°, the radius will be shortened by the same amount. Here the remedy is obvious.

"In order to test for astigmatism when the mirror faces the zenith, the arrangement shown in Figure 7 was employed. The light source and the knife-edge are, as usual, near *CC*. The plane mirrors *MM*, at 45°, are 8" in diameter. By rotating the large mirror the zone indicated by the dashed line may be tested for astigmatism. By adjusting the counterweights of the 'lifting component' of the supporting levers, any observed small amount of astigmatism may be removed.

"The work of making the mirror surface a satisfactory sphere having a radius of curvature of 1335.7" was completed in August, 1941. Parabolizing by alternate fine grinding and polishing was started August 30, and is now very nearly completed 'in the rough'; meaning thereby that the radii of zones are very close to the calculated values. The long work of smoothing and final figuring still remains to be done.

"Testing will be done near the

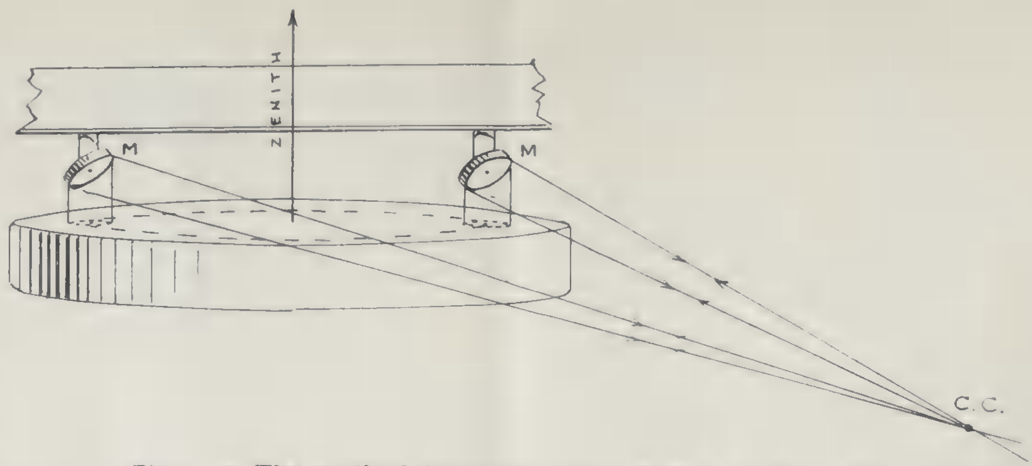


Figure 7: **The method for testing by zones for astigmatism**

center of curvature, using a method worked out by Dr. F. E. Ross and the author. The method is new as far as we are aware; however, it would not surprise us if it should prove to be 'old as the hills' — for no complete search of the literature has so far been made. The method is shown in Figure 8. The lens *L* is so designed that, when the light source is placed at a point between its focus and the lens, the spherical aberration at its virtual conjugate focus is such that the conjugate focal points for different zones of the lens coincide with the 'centers of curvature' of the corresponding zones of the paraboloid. The light source is shown on the axis. To the right of the lens the rays travel along the normals to the paraboloid, whence they are returned along the normals and would converge to the source — but, by the aid of the half-silvered plate *P*, the returning light is brought to the knife-edge as shown. The source and knife-edge may be interchanged.

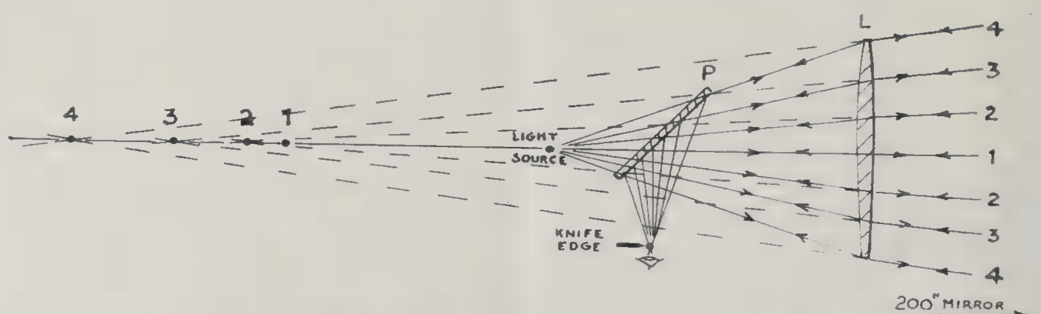


Figure 8: **Testing method to be used in the final figuring**

"The author wishes to express his deep appreciation of the assistance given him by Russell W. Porter in the preparation of this article."

EVER make a flat? Then you know the application of this verse, written by Anon Y. Muss:

An old man who lived in a cave
Knew how to make fringes behave.
  If he moved his head closer,
  And the fringes grew grosser,
He knew that the work was concave.

IF AS sometimes asserted, metal mirrors are inferior, optically, to mirrors of glass, they have certain special uses which justify them, and some like them anyway. Sidelight is thrown on their optical quality in a paper by Sydney J. Needs, Philadelphia, published in the "Transactions of the American Society of Mechanical Engineers" for May 1940, wherein he states that "there appears to be no metal which, when polished and examined even under low powers of the microscope, will present a surface of uniform appearance even remotely approaching that of well-polished glass."

Needs is not an amateur telescope maker but an engineer who undertook an extended research on the influence of boundary films of lubricant in machine bearings, and performed his experiments between two circular metal flats. In order to prepare for these experiments he first had to learn, from scratch, how to make the flats used in it, and in this he was aided to some extent by "A. T. M." (The pun about "from scratch" was unpremeditated but any who have been through the mill would perhaps vote to leave it in.) Needs continues:

"The metal surfaces invariably contained pits or non-metallic inclusions, iron carbides or traces of manganese in the form of gray spots with well-defined but irregular edges. Experience finally seemed to indicate that the best surfaces were produced by high-speed tool steel or a high-chrome tool steel. The chrome steel is corrosion-resistant and will hold its shape over long periods of time but it warps badly during the hardening process and is somewhat difficult to polish."

FOR advanced amateurs who have followed the hobby for years, made many mirrors, also flats, there is defense work. Write us. Even for such, this is hard, tough, grisly — make no mistake — hence we frankly urge others not to aspire to it.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

IT'S ABOUT TIME

By Paul M. Chamberlain

It's about horology, or the clock and watch hobby. Except the amateur telescope makers, no group of hobby enthusiasts can out-enthuse the amateur horologists, and this is a book by one of them, a structural engineer who collected 1200 watches covering in period three centuries. This impressive work describes their various escapements, as an engineer, and not merely a collector, would know them. It also gives numerous biographies of famous watch makers. A true feast for followers of this hobby. (490 pages, 7 by 10 inches, well illustrated.)—$7.60 postpaid.—*A. G. I.*

HOW TO TRAIN SHOP WORKERS

By C. A. Prosser and Philip S. Van Wyck

A shop-training manual designed for use by foremen and instructors in training workers in production and service jobs, in which the text covers such phases as planning of training, finding what to teach by job analysis, training the worker correctly, and methods, procedure, and equipment. (126 pages, mimeographed, 8½ by 11 inches, number of charts.)—$1.35 postpaid.—*A. P. P.*

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By Richard Headstrom

OSTENSIBLY for juveniles, many of these might find this book's language a bit hard going in spots; while many adults would find the tone condescending (so would some juveniles). Having thus criticized the book, we turn about and recommend it, despite its faults, even to adults who have purchased medium-powered microscopes, such as are on sale everywhere nowadays, because we think it better answers their needs than any of the more advanced adult literature. It tells what things to observe—common things—and where to find them, not for the expert but for the beginner, and in a way that permits a beginner to take real hold of the information. (232 pages, 5½ by 8 inches, 142 illustrations.)—$2.10 postpaid.—*A. G. I.*

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By Harry N. Holmes, Ph.D.

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CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

United States Imports as Possible New Crops for Experimentation is a detailed, 32-page list of crops worth considering for trial and possible large-scale cultivation, with the amount of each item imported and the country of its origin, also the price paid. Spices, drug plants, condiments, and odd items that may now become scarce and be worth growing as side items. *National Farm Chemurgic Council, 50 West Broad Street, Columbus, Ohio.—25 cents.*

Casco Projects is a 14-page booklet which describes a series of home workshop projects for the construction of various types of furniture. *Casein Company of America, Department CP, 350 Madison Avenue, New York, New York.—Gratis.*

Watson-Stillman General Bulletin No. 110-A is a 44-page catalog describing a line of self-contained, high-speed hydraulic machinery and equipment. Descriptive illustrations are presented on presses, pumps, jacks, and high-pressure valves. A section contains selective engineering tables pertaining to hydraulic problems. Request this bulletin on your business letterhead. *Watson-Stillman Company, Roselle, New Jersey.—Gratis.*

Wabash Exposure Bulletin, is a four-page compilation of data on lighting with flash and flood, for black-and-white and color, brought up to date to October 1, with bulletin No. 740P. *Wabash Photolamp Corp., Brooklyn, New York.—Gratis.*

Hardsteel Drills is a pocket-size booklet which gives information on a new type of drill which can be used for working hardened steel. The text includes instructions for use of these drills and for resharpening the various types. It is claimed that these drills can be used on armor plate, spring steel after tempering, and even for drilling holes in files. *Black Drill Company, 5005 Euclid Avenue, Cleveland, Ohio.—Gratis.*

Standard Carbide Tools Stock Sizes is a four-page bulletin giving complete specifications for 92 different types and sizes of these tools. In this line are available tools with tips of Vascoloy, Carboloy, Kennametal, and Firthite. *Tungsten Carbide Tool Company, Detroit, Michigan.—Gratis.*

Your Wings is a beautifully produced 32-page booklet which describes in some detail the services offered by one of the major airlines of the United States. Some historical background is given, with photographs of early plane types, and present-day operating methods are described. This booklet will interest every reader who wants to know more about our vital air transport system. *United Air Lines Transport Corporation, Municipal Airport, Chicago, Illinois.—Gratis.*

The Kodak Data Book of Formulas and Processing is a 65-page booklet, just issued by the Eastman Kodak Company as the latest in their list of Kodak Data Books and Kodaguides. All the Kodak formulas are covered in the book, which also includes the "why" and "how" of developing and printing. *Eastman Kodak Company, Rochester, New York.—25 cents.*

Pioneering the Cathode-Ray and Television Arts is a 32-page pamphlet describing the work of one organization which has been actively associated with these arts for the past decade. It gives a broad view of the cathode-ray tube in its many applications and of its special use in television reception. *Allen B. Du Mont Laboratories, Inc., Passaic, New Jersey.—Gratis.*

Industrial Brush Bristles is a 14-page pamphlet describing and illustrating a wide variety of uses for nylon bristles. Included in the booklet are samples of these bristles. Request this booklet on your business letterhead. *Plastics Department, E. I. Du Pont de Nemours & Company, Arlington, New Jersey.—Gratis.*

Condensation of Moisture and its Relation to Building Construction and Operation, by Frank B. Rowley, Axel B. Algren, and Clarence E. Lund, is a 70-page technical bulletin which considers the subject of its title in both insulated and uninsulated houses. Request Bulletin No. 18. *University of Minnesota, Minneapolis, Minnesota.—40 cents.*

Photography as an Extra-Curriculum Activity, by C. B. Neblette, is an eight-page folder available to teachers and school administrators. *Rochester Athenaeum and Mechanics Institute, Rochester, New York.—Gratis.*

Climate and Man is the 1941 Yearbook of the United States Department of Agriculture, and this year its 1248 pages are devoted entirely to weather and climate, largely in relation to crops but still so broadly as to be of value to all country-minded persons. It contains detailed data on the climate of each state. *Superintendent of Documents, Washington, D. C.—$1.75.*

Trains is a year's volume of a new magazine devoted to subjects of interest to railfans, now in its second year of publication. Contains an index of the articles published in the 12 bound numbers. *Kalmbach Publishing Company, 1568 West Pierce Street, Milwaukee, Wisconsin.—$2.50.*

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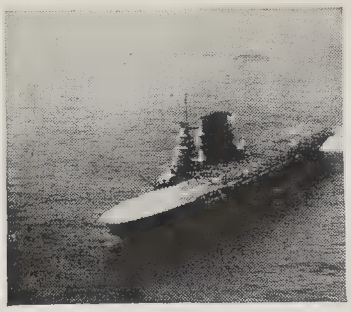

FLOATING airports of the Navy — plane carriers — will total 18 when the present Navy program is complete. Each will have a complement of 160 pilots and will carry from 70 to 90 planes. Our cover illustration, an Official United States Navy photograph, shows a plane being launched from the *Saratoga*.

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SCIENTIFIC AMERICAN

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NINETY-EIGHTH YEAR — ORSON D. MUNN, Editor

MARCH • 1942

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OUR *Point* OF VIEW

SCIENTIFIC AMERICAN AND WAR

War—all-out war, total war, call it what you will—is reaching deeply into the very lives of every resident of the United States of America. There is no phase of existence that modern warfare does not affect. And while it is not news to tell of the inroads that war-time production is making on civilian materials of all kinds, it seems proper to record here some of the things that are happening or are in prospect and which will influence the future course of this magazine.

Physically, a magazine consists merely of ink on paper, and it is the paper that you can hold in your hand, see the color of, feel, and—if you want to—taste. That is, the paper itself is really the physical material that you buy when you obtain your copy of Scientific American. Here is where you will notice the first change. The color of the paper—it is white, but there are many degrees of whiteness in paper—will incline more toward a natural or yellow shade. This is due to restrictions on civilian uses of chlorine, the chemical that is used to bleach the pulp from which paper is made. Then, too, we have already been restricted in the amount of paper which can be bought during 1942—a serious situation when circulation figures are climbing.

What are we going to do about it? In the matter of paper color, there is nothing that can be done. We can only exercise every effort, with the assistance of the printer, to achieve the best possible printed result with the paper available. As to quantity of paper: There is every hope that the restrictions will not be too drastic but it will undoubtedly be necessary in some of the issues of 1942 to reduce the number of pages. This will, of course, be done only as a last resort, but already steps have been taken to make up, at least in part, for any such restriction. As will be noticed, the issue now in your hands is set in a different type from that of previous numbers. This new type, while just as readable as the former font, is a bit more compact; as a result it is possible to get about 10 percent more words on a page. Thus, as long as we are able to maintain normal size, the reader will get the benefit of more text; when reduction of pages becomes necessary, if it does, the net result over a period of months will just about balance.

MILTON WRIGHT

On December 29, 1941, Milton Wright, formerly an associate editor on the staff of Scientific American passed away at his home in Freeport, Long Island. Mr. Wright, who was connected with this magazine from 1925 to 1929, will be particularly remembered for his outstanding articles on successful but little-known inventors in the United States. From 1929 to his death, Mr. Wright devoted his energies to writing and lecturing on business procedure and psychology. His passing has left a definite gap in that group of former associates of the editorial staff who, while going into other fields, have remained firm friends of Scientific American.

Then, too, photo-engravings, from which photographs and drawings are reproduced, use copper, zinc, and a number of chemicals; the metals are strategic materials needed for military purposes, as are also some of the chemicals. How soon photo-engravers will be curtailed in their operations, due to inability to obtain their necessary supplies, is not yet known. When and if this does happen, it is obvious that fewer and fewer illustrations will grace the pages of all magazines.

In any event, and no matter what happens, the publishers of Scientific American pledge that the magazine will continue on the same high plane that it has occupied for the 97 years of its existence. Nothing will be permitted to interfere with the character of the editorial content. When it comes to belt-tightening in the material things of production over which we have little or no control—and we hope that any such belt-tightening will not be drastic or long-lasting—we trust that our readers will understand the reasons for it and will continue to lend the loyal support that has always been the pride of the publishers of one of the oldest magazines in the world.—*A. P. P.*

THE PATENT OFFICE MOVES

It seems strange that, in a country built on an industrial foundation, which foundation in turn is based on the bedrock of a patent system second to none in the world, even the emergency of war should be allowed to interfere with the smooth functioning of the Patent Office. Yet just that is being done, despite the fact that the operations of the Patent Office assume vastly increased importance to the welfare of the nation in times of war.

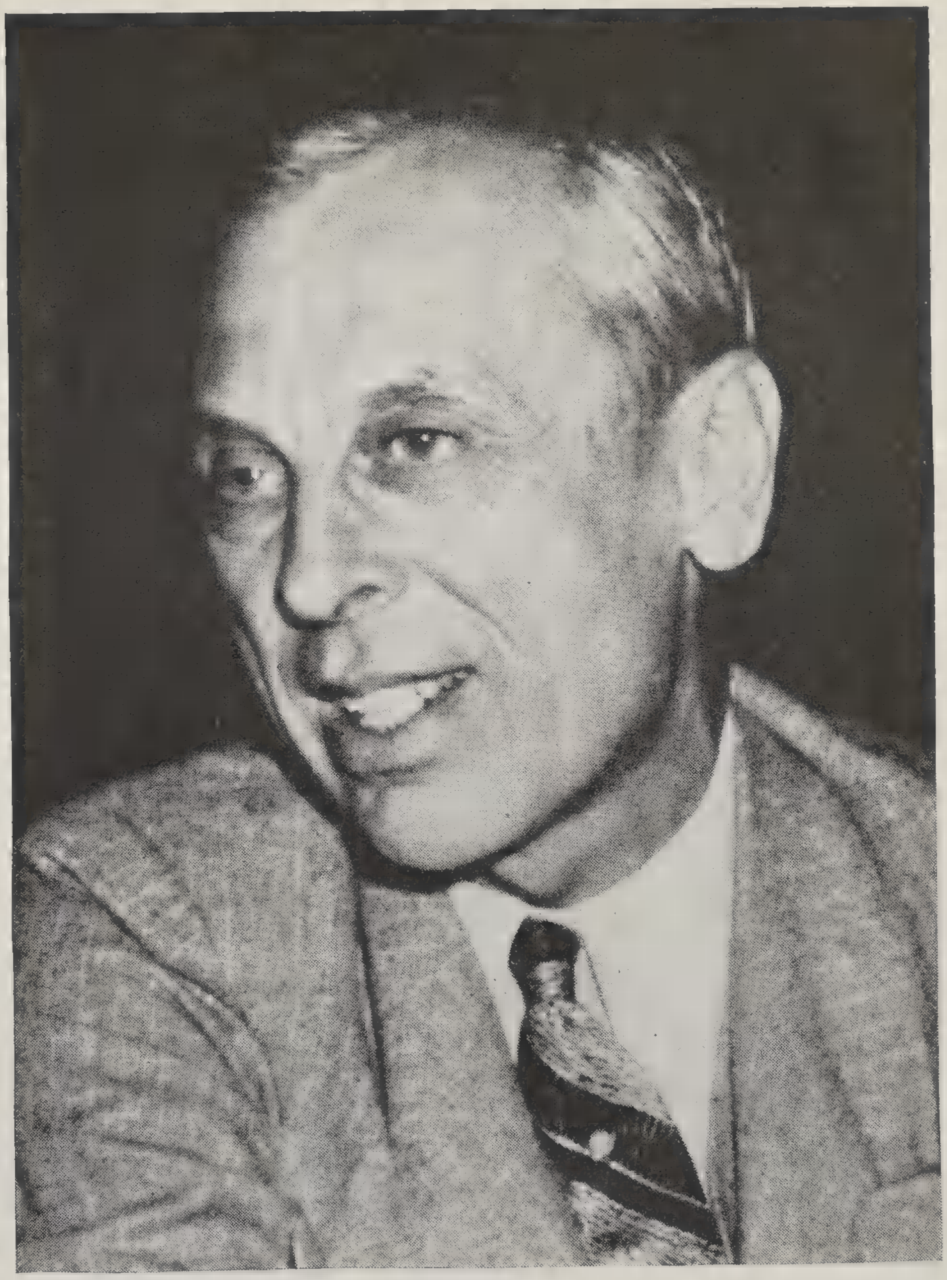
What actually is being done is that part of the Patent Office is being moved from its convenient and well-designed quarters in Washington to an old tobacco warehouse down in the freight yards of Richmond, Virginia. Reason? Vice President Wallace, recently made Chairman of the Economic Defense Board, wants the present housing facilities of the Patent Office for his agency. And he is getting them.

At the time of writing it appears that files of patent and trade-mark copies will be kept in Washington for purposes of conducting searches. Patent applications and amendments will continue to be filed in Washington, after which they will be transferred to Richmond. That this procedure will throw an added burden on an already overworked Commissioner and executive staff goes without saying. That it will slow up the intricate and time-consuming tasks of the entire Office is equally obvious.

An integrated Patent Office is essential to the economic structure of the entire nation. Even the sacrifices made necessary by national emergencies should be carefully weighed before deciding upon such upsetting and radical changes. Surely there are other government agencies that could better be put to inconvenience than the Patent Office. How about the Economic Defense Board itself?

It is to be hoped that, costly though it would be in time and money, the error of this change will soon be detected, and the Patent Office will once more be restored to a unit basis.—*O. D. M.*

Personalities in Industry



ALFRED P. SLOAN, JR.

OFTEN referred to as an outstanding example of the new school of corporation executives, Alfred P. Sloan, Jr., Chairman of the Board of General Motors Corporation, has expressed his industrial philosophy in the following manner:

"My objective is to impress the vital necessity of searching aggressively, and with an open mind, for the fundamental truths in the broader relationships of industry to society; the separation of truth from the fallacies; and the promotion of the broadest possible understanding on the part of all people as to the effects of these fundamental truths on industry's ability to accelerate human progress. Industry must further expand its horizon of thinking and action. It must assume the role of an enlightened industrial statesmanship."

Mr. Sloan was born in New Haven, Connecticut, May 23, 1875. When Alfred, Jr., was five years old, his family moved to Brooklyn, New York. Before completing his high-school education in Brooklyn, young Sloan gave up his regular studies and took special instruction to prepare for college. He was disappointed when he found that he could not enter college immediately, because he was too young. A short time later he entered the Massachusetts Institute of Technology, where he completed a four-year course in three years. He was graduated with a degree of Bachelor of Science as the youngest member of his class.

Young Sloan began work as a draftsman with the Hyatt Roller Bearing Company in Newark, New Jersey. At this time the automobile industry was becoming more active. Experience proved that a steel axle bearing of the roller type was needed. Mr. Sloan worked on the bearing invention of John Hyatt, found funds to finance the project, and went on the road to sell the bearings. From the start Mr. Sloan's activities brought him into direct contact with automobile leaders and the years which he devoted to the activities of the Hyatt Roller Bearing Company gave him a diversified schooling in many phases of the automobile business. He gained an intimate knowledge of draftsmanship, designing, engineering, production, sales, advertising, and executive direction.

Because of his aptitude for organization and his penetrating business sense, Mr. Sloan was named President of the United Motors Corporation, organized in 1916. In 1918 United Motors Corporation became a part of General Motors Corporation. Mr. Sloan was named Vice-President of General Motors in charge of accessories and was made a member of the Executive Committee. He proved his ability to direct successfully the many activities of the Corporation and on May 10, 1923, he was elected President. Mr. Sloan served in this capacity until May 3, 1937, at which time he was elected Chairman of the Board.

A striking figure, well over six feet in height, Mr. Sloan is broad-shouldered and lank. His face is long, narrow, and mobile; his skin clear and tanned; his eyes are set well apart, surmounted by a high forehead. He has an attractive smile and a voice characterized by an almost Southern drawl at times. He is filled with nervous energy.

As an executive, Mr. Sloan is a distinct contrast to the "sledge-hammer" business personalities of an earlier era. He does not lack force, but force is not his outstanding quality. He is a doer, but perhaps even more conspicuously, he is a thinker. His task is to deal with human relationships upon a vast scale, to study economic principles, to lay out policies for the permanent direction of his prodigious company. He combines in a most interesting way the qualities of a man of action and a philosopher.

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of March, 1892)

CRUISERS—"The splendid steamer *Majestic* reached New York from Liverpool on the 24th ult., her average speed being 20.41 knots for the voyage, or about 23½ miles per hour. What the navy of the United States needs is a fleet of twenty-five cruisers like the *Majestic,* which in time of peace should be employed in active service, such as transport of the mails, thus keeping them always in effective condition."

GATLING—"The latest model of the Gatling gun, shown in the accompanying illustration, has been given the name of

the 'Police gun,' from its admirable adaptation for police or mounted service, for guarding railway trains, banks, or safe deposit institutions, or for use on vessels, yachts or boats. Its weight is but 74 pounds, so that it can be carried if necessary by a single man, or, with all accessories for the field, on a single animal. It has six barrels, and the feed is positive, enabling it to be fired at the rate of 800 shots per minute at all angles of elevation and depression. When set up in the back part of a patrol wagon, and served by two or three men, it is designed to do more effective work in dealing with a mob or in dispersing rioters than could be accomplished by a whole company of infantry."

POWER TRANSMISSION—"In a recent lecture on 'The Induction Coil,' at the Royal Institution, by Prof. Fleming, the employment of transformers for raising or lowering the pressure of alternating currents was illustrated. . . . A current of electricity, supplied to the lecture table at a pressure of 100 volts, was raised to 2,000 volts by means of a Mordey transformer. At this high pressure it was sent across the room by means of two very thin wires; then reduced again in pressure to 100 volts by another transformer, and used to illuminate a large incandescent lamp. The lecturer pointed out that a great economy was effected in the cost of transmission of the energy by thus sending the current at high pressures."

RIVERS—"Geographers claim that there are twenty-five rivers on the globe which have a total length each of over 1,000 miles. Of these, two, the Mississippi from the source of the Missouri in the Rocky Mountains to the Eads jetties, and the Amazon from the source of the Beni to the isle of Marajo, are over 4,000 miles in length. To be exact, the former is 4,300 and the latter 4,029 miles from the source to the places where their waters are mingled with those of the ocean."

REQUIREMENTS—"The internal organism of the traveling salesman should be a mixture of mule, ostrich, and camel. Part mule, that he may be able to sleep on his feet if no better accommodations be at hand; part ostrich, that he may be able to eat and digest anything set before him; and part camel, that he may, if necessary, go a long time between drinks."

ALLOY—"The advantages of an addition of aluminum to fluid iron are important. With moderate care absolutely pure and solid castings can be obtained capable of receiving a high polish. An addition of aluminum is especially to be recommended for the manufacture of steam cylinders, engine castings, press cylinders, and generally for castings which are to be subjected to high pressure."

RESISTANCE—" 'If you take a good conductor like copper, and run the temperature down, its resistance almost disappears at very low temperatures; hundreds of degrees below zero copper is almost a perfect conductor. If you heat it up, it becomes more and more resisting. Let us take glass—a good insulator—or any insulating material, and run its temperature up; it loses its insulating power, and if we run it up until it gets to red heat, it approaches a conductor; so that all substances are conductors when they are hot enough.'—*Prof. Thompson.*"

AIR *vs.* ELECTRICITY—"Compressed air is, perhaps, the chief rival of electrical transmission. It is at present used chiefly in mines, where it is still a very successful rival of electricity, but from present appearances it is likely that it will gradually be replaced by the latter method. In Paris there is a large central station for the distribution of compressed air, and it seems to be in successful operation. It does not appear, however, that the advantages over electrical transmission are so great that it will not soon be replaced by electricity. Its introduction is not making the rapid strides that the introduction of electricity is now making."

GEMS—"Unfortunately, for some reasons, the sapphires of Montana have slipped through the fingers of the people who should own them, and are now mined by an English syndicate, that has paid in $2,000,000, the best stones being sent to London, where high prices are demanded for them. The diggings are known as the Spratt sapphire ground, and are about twelve miles north of Helena, on the Missouri River."

DIGESTIVE—"Pineapple juice is an acid fluid of specific gravity of 1.043. An ordinary pineapple yields 600 to 800 cubic centimeters of it. The proteid-digesting power is quite remarkable in its intensity. Three ounces of the juice will dissolve ten or fifteen grains of dried albumen in four hours. The action takes place in acid, neutral, or even alkaline media, thus resembling trypsin more than pepsin. . . . A well-known meat powder is said to be prepared with the help of pineapple juice."

CIRCULATION—"Blood travels from the heart through the arteries ordinarily at the rate of about twelve inches per second; its speed through the capillaries is at the rate of three one-hundredths of an inch per second."

PSYCHIC (?)—"A mysterious ringing of electric bells in a Swiss house was traced to a large spider, which had one foot on the bell wire and another on an electric light wire."

98TH YEAR — SCIENTIFIC AMERICAN — MARCH 1942

FOOD FOR BRITAIN HELPS US

An Apparent Paradox in Modern Nutrition

T. SWANN HARDING

WHEN the first 2,000,000 selectees had been examined for the draft, exactly half of them were turned down for poor physical condition. About one third of this disability was attributed to malnutrition. The Department of Agriculture chimes in and says that only one fourth of all our families customarily have good diets, something over a third have fair, and the rest have poor diets.

Then, right on top of that, came an announcement in November, 1941, that we had sent to Great Britain 2.2 billion pounds of cheese, dried milk, evaporated milk, pork, lard, eggs, and other food, between April and November 1, 1941. Furthermore, it was stated that we planned to send Britain enough food in 1942 to fill a freight train that would reach clear across the United States. That food would supply one fourth of the British people.

Now does all that make sense? Isn't there a paradox here? Actually it does make sense but, like everything in modern civilization, the subject is complex.

First off, it is true that we Americans, though fed better than any other people on earth in history, have not been well fed. That means we have not all had a "best adapted diet," as the nutrition scientists say—a diet containing ample protein, calcium, phosphorus, iron, vitamin A, thiamin, ascorbic acid or vitamin C, and riboflavin.

The survey made not long ago by Hazel K. Stiebeling and her aids of the Bureau of Home Economics indicated that almost one third of our people live on poor diets. Underfeeding extends also to farm people, only half of whom have really good diets, while one fourth have fair and one fourth poor diets. The reason for that is that so many single-crop farmers fail to grow a part of their own food, a step the Department of Agriculture now urges them to take.

Approximately 54 percent of our non-relief people in villages and cities are in families with annual incomes of $1499 or less, and can afford to spend only from 6 to 10½ cents per person per meal for food. Families with annual incomes of $499 or less can spend but 6 cents, those with incomes between $1000 and $1499 can allow about 10½ cents, but in families with incomes between $3000 and $4999 a year, this sum goes up to 18 cents. How much, then, does it cost to buy an adequate diet?

HEALTH SCIENCE

American soldiers get a complete, well-balanced, but not over-fancy diet. A soldier's weekly food allowance includes: 4 pounds, 6 ounces of fresh beef; 14 ounces of chicken; 1 pound, 12 ounces of fresh pork; 9 pounds, 3 ounces of fresh and canned vegetables; about 1 pound of cereals and dried vegetables; about 2 pounds of fresh and canned fruit; 14 ounces of coffee; and 7 eggs. The Army spends 21 cents per soldier per meal, retail prices, for that ration.

You can readily make your own comparisons from the figures above. It is also of interest that the weekly allowance of the British in October 1941 was 7 ounces of meat, 3 ounces of cheese, 4 of ham and bacon, and 1 egg, plus certain other unrationed items.

The monetary and social cost of this malnutrition is huge. What we Americans could do if we were all well fed surpasses our wildest dreams. Malnutrition destroys nerve health, lowers work efficiency, impairs learning power. For many years we spent hundreds of millions trying to educate children who were too far gone in malnutrition to learn. They were retarded in their work. It took twice as long to get them from one grade to another as it should have, and that points to plain extravagance.

Public attention has now been drawn by the National Nutrition Conference to such facts as these—facts which nutrition scientists had known for years. One physician, for example, announced in 1929, as a result of his own investigation, that one fourth the school children in the United States were suffering directly from malnutrition. That was 4,000,000 underfed youngsters. He said that one third of the Chicago school children and two thirds of those in New York were afflicted with nervous disorder, which often accompanies malnutrition. About 14,000,000 children then had defective teeth, another evidence of undernourishment.

YET numerous studies both here and in Great Britain have shown that supplementing the ordinary diet of underfed children with a pint or so of milk a day will alone produce mental alertness, normal activity, improved learning capacity, and all-'round well-being and efficiency. This frequently happened when the child's previous diet was supposedly a good one. Indeed, Sir John Orr said not long ago in a speech in Washington, D.C., that undernourished women become "co-operative" when properly fed, and that is really something.

Not even intelligence is a constant, nor is it a purely hereditary characteristic. A decade ago Dr. John Monroe demonstrated that many low-grade intellects become normal or even high grade when the stomachs of their possessors get an eggnog (no rum, please) twice daily to stoke up on.

Fatigue and nervousness are not necessarily unavoidable, or incurable, either. In this connnection consider 11 white women at Mayo Clinic who were the subjects of an experiment. The idea was to find out what happened when people didn't get their thiamin, or vitamin B_1. So these women, who normally

did ward housekeeping, laundering, and sewing, were fed the following thiamin-deficient diet:

White bread, corn flakes, potatoes, polished rice, sucrose, skim milk, beef, cheese, egg white, butter, vegetable fat, cocoa, gelatin, canned fruits and vegetables, and coffee. The diet was supplemented with brewer's yeast, halibut-liver oil, vitamins C and D, iron, calcium, and phosphate, but it contained only about 0.45 milligram of thiamin daily, which is so little that we may ignore it. What happened?

Nothing—for about three months—then plenty. Then capricious appetites appeared, with nausea, vomiting, anemia, loss of weight, lowered basal metabolism, and "changes of behavior and other objective evidences of psychosensory and psychomotor disturbances, not manifested during the period of preliminary observations." In short, the good ladies got so irritable, quarrelsome, and inefficient that they couldn't do their work.

They became weak, inattentive to details, confused in thought, uncertain of memory. They lacked manual dexterity and began to fight and argue with each other all the time. But once thiamin was sneaked into their diets these disturbances ended and they could go back to work. It took only a milligram or two of thiamin daily to do that, too, and there are a thousand milligrams in a gram—which itself is about one thirtieth of an ounce. Fancy that hair line between healthy efficiency and complete uselessness.

If people are to fight an enemy or to work in a factory or on a farm upon defense projects, they must be well fed. The Nazis have been very careful to see to it that all Germans who do anything of importance get a complete, if somewhat monotonous, diet. But they have deliberately used malnutrition as an instrument of political action in the territories they have subjugated. For if people are kept underfed, they are too listless to revolt or to make much trouble. The British, on the other hand, say to us: "We can increase our production 25 percent more and lick the Nazis, too, if you Americans will surely provide us with the animal proteins needed to stoke our biological furnaces."

Since we are making of the British Isles an outpost in the effort to destroy Hitlerism, it is extremely important that the British be well fed. It is worse than useless to supply them with the guns, the ammunition, and the other instruments of modern warfare, if we deprive them of the food which alone can keep them in proper shape to fight a good fight.

But it is also important that all our own people be well fed. The basic freedom of the four mentioned by President Roosevelt is freedom from want. Unless people are well nourished they fail to appreciate freedom to worship as they please and freedom of speech; while fearfulness, or apprehensiveness, is one symptom of malnutrition.

Then what have we done for our own underfed? Through the Surplus Marketing Administration we have arranged to purchase huge quantities of food nearest the source, the basic producer, thus procuring it cheaply, and we have distributed this food to the undernourished —often, as in the school-lunch plan, utilizing idle labor to do this. Some food is purchased directly and then turned over to State welfare agencies. Some is used under the food-stamp, free school-lunch, and cheap-milk programs. Some farm commodities have been diverted to by-product or other uses.

Between October, 1933 and July, 1940 about $565,000,000 worth of farm products were bought from farmers and distributed to the needy in this country. This involved, among other things, 250,000,000 pounds of butter, 27,000,000 pounds of cheese, 76,000,000 quarts of fluid milk, and so on. In short, we have fed millions of our own half-starved people. Whatever happens in the future, we have decided, at least, that we cannot afford to let a generation grow up physically and mentally handicapped through malnutrition during childhood while we debate the form that basic social and economic reorganization should take.

What, then, of the future, and how does the better nutrition of American citizens tie in with food for Britain?

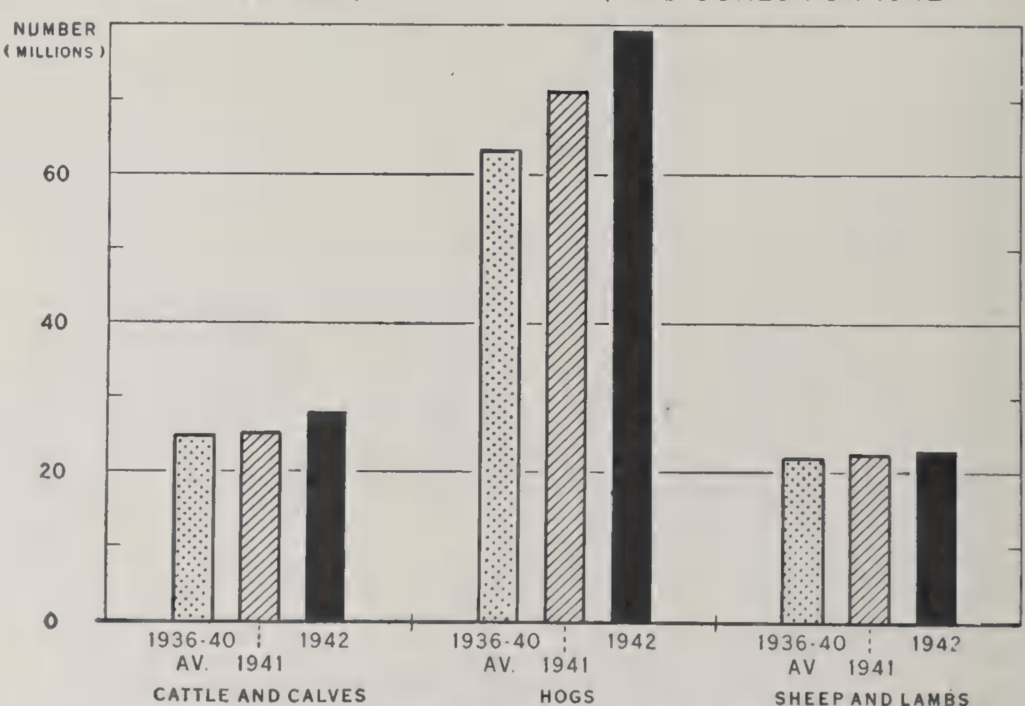
In September, 1941, Secretary of Agriculture Wickard announced the so-called food-for-freedom program. It involved the establishment of 1942 production goals for all essential agricultural commodities. These goals had been established scientifically on the basis of a thorough canvass of the needs of improved nutrition in the United States and the requirements of nations fighting Hitlerism. Every farmer will be contacted by his local committeeman in a nation-wide sign-up campaign.

The agricultural adjustment machinery will be utilized to increase the production of hogs and lard (by feeding Ever-Normal Granary grain to hogs), milk and milk products (by stepping up the grain feeding of dairy cattle), and eggs. Those are Great Britain's main requirements. At the same time the agricultural adjustment machinery will be used still further to curtail production of cotton, wheat, and tobacco, of which we have ample surpluses.

Shipments to Great Britain for 1942 will be simply stupendous—the equivalent of five billion pounds of milk, for example, in the form of dried milk, evaporated milk, and cheese—or enough milk to fill a pipe half a foot in diameter reaching around the Equator three times. The British will also get 1.5 billion pounds of pork and lard, representing enough 230-pound hogs, stand- 1½ feet apart, to reach from the northernmost point in North America to the southernmost in South America.

Our 1942 production goals also require us to send Britain a half billion dozen eggs, some 18,000,000 pounds of canned poultry, enough fresh fruit to fill 750 miles of railway cars, and enough canned vegetables to fill 22

MEAT ANIMALS: TOTAL UNITED STATES SLAUGHTER, 1936-40 AVERAGE, INDICATED 1941, AND GOALS FOR 1942



Data on actual slaughter, but not including production goals

miles more. Now what relation do these quantities bear to our normal domestic production and consumption?

Much depends on how you look at it. Great Britain normally produces only about 37 percent of her own food, and her food consumption as a whole dropped below normal during the 1940–41 winter. To balance her national diet she would need from us one half our normal output of cheese, one and one half times our normal production of evaporated milk, and five times our normal production of dried eggs. Yet such quantities do not bulk so very large when compared with our total agricultural production.

For example, while wheat production is to be reduced 15 percent under the 1942 goals, lamb and mutton production will have to be increased only 2 percent, milk 7, eggs 10, chickens 13, pork and lard 12, and the quantity of beef and veal marketed 10 percent. If we use 100 as the index of farm production for the 1924–29 period, the average for 1936–40 was 105, the 1941 index will run about 113, and the 1942 production goal only 115. So we simply need an over-all increase of 2 percent in farm production to achieve the goals.

Britain will take only 6 to 8 percent of our output of the particular farm commodities she requires of us.

Take milk as an example. During the latter 1930's we produced about 106 billion pounds a year. In 1940 we had an all-time high in farm production and the output was 111 billion pounds of milk. The 1941 output is expected to top that by being 117 billion pounds. The goal for 1942 is only 125 billion pounds, of which 5 billion will go to Britain and 3 will remain here to improve the American diet.

But if all Americans had a "best adapted diet," this country would utilize 20 percent more milk and 15 percent more butter. We should use fluid milk at a rate of 295 quarts a head a year instead of 168 quarts as at present. Incidentally, we should also use 70 percent more tomatoes and citrus fruits, 100 percent more leafy green and yellow vegetables, and 25 percent more eggs.

Getting back to the milk can, though, this nation would use 140 billion pounds of milk annually, if all had "best adapted diets." Compare that with the 125-billion pound production goal for 1942 which includes Britain's 5 billion pounds.

Consider also what it would mean if we all got our full quota of the other foods mentioned above. It would mean an increase in our crop acreage equal to that used for export farm commodities in our best foreign-trade years. It would require a cultivated area equal to that in the State of Iowa—just to feed our own people.

We shall step up our agricultural productive capacity to help lick the Nazis. We shall aid in feeding the nations which are fighting aggression. But, at the very same time, we shall improve the nutritional status of our own people. When peace comes, we shall not destroy this productive capacity we have built. Instead, we shall let it run to full capacity and learn how to distribute the wealth it produces equitably to all who need it.

Corn into hogs, hogs into food, food into victory

Secretary Wickard, a dirt farmer himself, with a profound feeling for the underfed underdogs, is determined that all citizens of the United States shall be guaranteed a full basic diet after the war. Secretary Morgenthau has echoed this by saying: "My own feeling is that we should guarantee to every man, woman, and child the right to have

They thrive on penny milk

enough milk and butter, enough fruits and vegetables, enough of the protective foods of all kinds so that every one can be fit to do his part in the world of tomorrow."

This country is rich enough agriculturally to recognize every citizen's right to have a minimum standard of food upon which he can live the life of a free man. Exactly that is what officials of the Department of Agriculture mean to see provided for all.

A period of maladjustment, depression, and despair could follow this war. But post-war plans are already being formulated to prevent that. These plans include rural public works, reforestation, soil conservation, flood control, electrification, education, medical care, better market facilities, better housing, libraries, and also industrial decentralization, along with such extension and modification of the food-stamp and school-lunch plans as proves necessary to give every American his minimum basic diet. These plans are of supreme importance as a bridge to a better way of life.

Until recently, we Americans have displayed little ability to make equitable distribution of the vast wealth that science and technology have lavished upon us. Yet, considered as a functional or engineering problem, provision for the material needs of the common run of men offers no insuperable difficulty. We have the resources, the equipment, the techniques, the processes, the research laboratories, and the trained manpower.

Fundamental in post-war days will be experiments in and study of distribution. These, alone, can aid us in effecting the required readjustment of agricultural and industrial production, and in cushioning the social damage that might otherwise ensue. When adequately financed, they will maintain a floor beneath the physical health of our people and prevent the nation from repeating past mistakes. Ultimately, by making full provision for the basic needs of our own people, we shall greatly increase our national income and well-being.

That is what the food production goals for 1942 and food for Britain really mean.

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TRANSFUSIONS

Blood Types Now Quickly Determined

A new testing technique, employing the dried serum of rabbit's blood, will be used by army surgeons to classify soldiers' blood into one of the four known groups quickly, safely, and cheaply, according to Lederle Laboratories, Inc., who developed the new method. The rabbit serum is used only for testing purposes and not for transfusions. Thus invaluable time will be saved in giving blood transfusions, when needed, to soldiers in the United States Army because each man's identification tag will now be stamped to designate his blood group determined by army surgeons in advance. With this information always available, the selection of the man to give blood safely to another can be made immediately.

Transfusions can be given safely only after tests have shown that the blood of the donor will safely mix with that of the recipient, and only human blood can be used. If blood of the wrong type should be given the patient, clumping of the donor's cells would occur in the body of the recipient, causing a shock reaction and possibly death. The necessary tests, made by the old method with the serum of human blood, were time-consuming when minutes might mean the difference between life and death for the patient.

The new testing technique employs dried serum from the blood of rabbits which have been previously injected with human blood corpuscles of known groups. This treatment increases the potency of the rabbit's blood in the substances which differentiate the several groups of human blood. The corpuscles are separated from blood drawn from the treated rabbits, the clear serum is treated to remove non-specific substances and then reduced to a powder by careful drying. In the dry, powdered form, the serum retains its value for test purposes indefinitely.

Two types of dried rabbit serum are necessary for the typing of human blood. In making the test a single drop of the unknown blood drawn from a person is diluted with a small amount (about eight drops) of normal salt solution and two drops of the blood solution are placed separately on a clean slip of glass. To one drop is added the tiny amount of Anti-A powdered serum that can be picked up on the end of a tooth pick. Anti-B serum is similarly added to the other drop. At the end of half a minute, the two drops are examined with the naked eye or a hand lens. If no clumping of the blood occurs in either drop, the blood is Group O. If clumping occurs in both drops, the blood is Group A-B. If clumping occurs with one and not the other, the blood belongs to Group A or B according to which kind of dried serum causes the visible clumping.

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SENSITIVE—Light so feeble that it cannot be measured by the most delicate optical instruments can be perceived readily by the human eye, experiments conducted at Columbia University show. The human eye, it was found, can perceive light if it falls on as few as five molecules of the receiving substance of the retina.

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GRAY HAIR

Darkened by Doses of Vitamin B

"A marked darkening" of previously gray hair and growth of "new natural colored hairs" in 30 human beings has been achieved by small daily doses of one of the newest of the vitamin-B group, para-aminobenzoic acid, according to Dr. Gustav J. Martin, of the Warner Institute for Therapeutic Research, and S. Ansbacher, of the research laboratory of the International Vitamin Corporation, states *Science Service.*

This is the first report before a scientific society of the "cure" of gray hair in humans by this vitamin, although there have been a number of reports of the darkening of gray hair in rats and mice with doses of both para-aminobenzoic acid and other B vitamins.

Like the other B vitamins, the para-aminobenzoic acid is found in yeast and liver. For the treatment of gray-haired humans the synthetic vitamin, which costs about ten cents a pound, was used. The daily dose is 100 milligrams (about two-hundredths of an ounce). But Dr. Martin warned that it should be taken only under a physician's direction because this chemical has other effects, some of which are only just being discovered. It counteracts the curative effect of the sulfa drugs, for example, and under certain conditions might raise the blood pressure.

MIND AND BODY

Does Mental Receptivity Control the Physical?

An amazing story of how a childless couple were finally able to have a child of their own after they had decided to adopt a baby has been told in *Psychosomatic Medicine* by Dr. Douglas W. Orr, Menninger Clinic, Topeka, Kansas. Not infrequently a childless wife becomes pregnant some time after adopting a child. Some psychologists believe the supposed "sterility" was really caused by an unconscious opposition to childbearing. This opposition disappears with the adoption and rearing of a child. Deep psychological barriers are lowered, and the machinery of pregnancy is enabled to function.

Dr. Orr's case was somewhat different. The wife's apparent previous inability to bear a child was traced by psychoanalysis to her own childhood. Her father had wanted a boy. To grant this wish as far as possible, the mother brought her daughter up to be tomboy. She was made to wear tailored clothes, her boyish figure was praised, and she was encouraged to express her athletic abilities by playing golf with her father.

Because of this, Dr. Orr continues, the young girl came to believe "she could not have a child because she was not enough like a woman, and she had no confidence that she could care for a child if she were to have one."

This state of mind carried over into married life because her husband encouraged her to work. To her this meant, "you must go on being like a man." This belief that she was too masculine, the psychoanalysis indicated, prevented her from becoming pregnant.

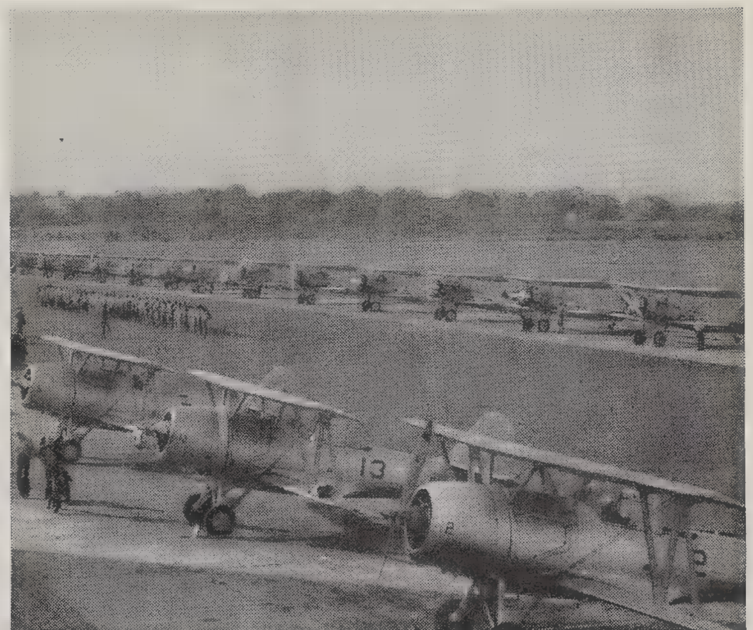
However, when husband and wife decided to adopt a child, she was encouraged by her husband to stop work. Her resignation, Dr. Orr concludes, "enabled her better than ever before to turn toward and accept her basic femininity." Shortly after her resignation and adoption of the child, the wife became pregnant.—*Science Service.*

Our Navy's Air Arm

Flying Sailors of the United States Have Long Been Regarded as Best Trained in the World

JAMES L. H. PECK

Our Navy is at war. Its operations in both the Pacific and Atlantic involve two principle strategic missions: the ability to obtain enemy information quickly and with reasonable security; the firepower and flexibility to strike at these Axis sea forces once their intentions become apparent. This applies equally to cruisers, submarines, or aircraft—or the Navy as a whole—but the aircraft, because of their speed and range, are particularly suited to carry out these tasks. No matter how formidable sea power may be on the surface, it requires the support of aviation to gain a decision against an enemy's sea-air combination. Deprived of such support, surface vessels cannot operate with the necessary freedom of action.



All illustrations Official Photographs, U. S. Navy
Advanced trainers — obsolete service planes

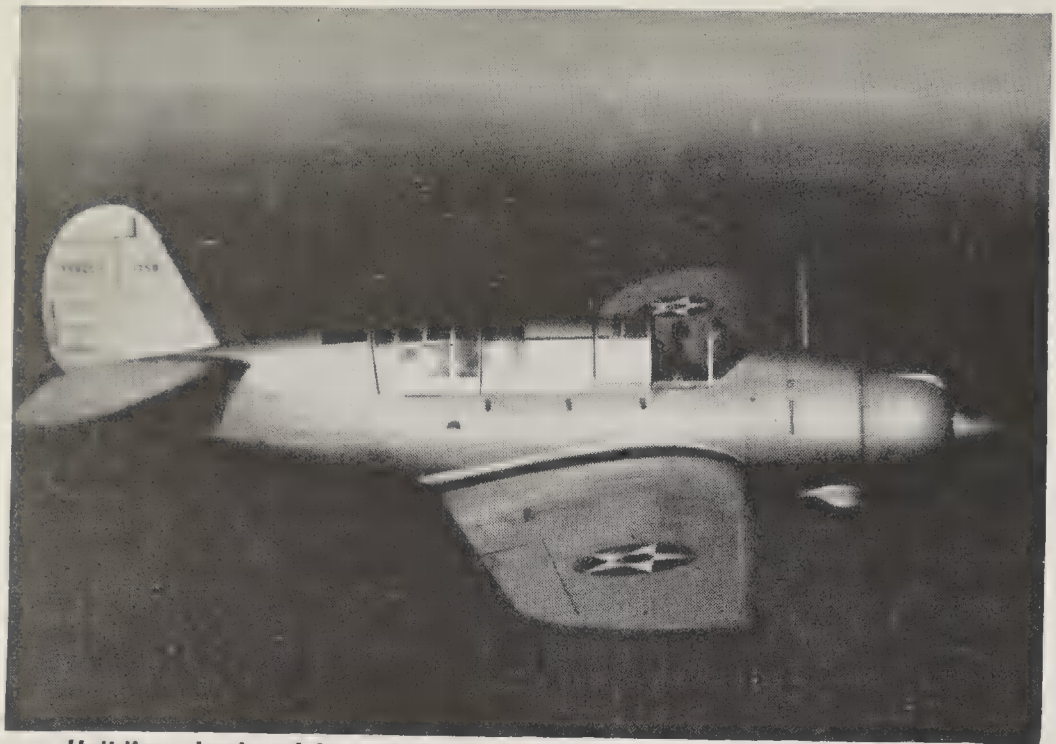
This is not news to the United States Navy. In February, 1913, Lieutenant John H. Towers—now Rear Admiral and head of the Bureau of Aeronautics, Navy Department—performed the fleet's first patrol flight and "discovered" the enemy at sea. Even before this flight was accomplished, Towers and Glenn Curtiss—who had taught the former to fly in 1911—envisioned a long-range flying boat. The Curtiss planes of the famous NC type were the first of such craft to be built, the forerunners of our crack "VPB" patrol planes. In November, 1918, one carried aloft 51 persons in a test flight. That was news in those days. In the Spring of the following year, another flying boat, the NC-4, completed the first transatlantic flight; which was also big news. Today, our patrol bombers are capable of speedy non-stop crossings in routine operations. Three of the newer types can make it a round trip or remain awing for a couple of days at a time.

Not so farsighted are the eyes of the "VSO" aircraft which are carried to sea aboard battleships and cruisers and launched from catapults for scouting purposes. These seaplanes, however, are highly essential for a number of reasons which will be examined later. In November, 1915, Lieutenant-Commander H. C. Mustin made the first catapult launching of an aircraft from the U.S.S. *North Carolina*. Although this artificial take-off was the first to be made from a vessel, Lieutenant T. G. Ellyson—along with Towers and Lieutenant John Rodgers, one of the three original Navy aviators—had piloted a flying boat three years prior to this from a catapult built on a small dock at the Washington, D. C., Navy Yard. Present-day scout-observation craft take wings from our battleships and cruisers by means of 70-foot catapults motivated by compressed air.

Just as America pioneered in these means of finding an enemy at sea, so did we conceive and develop methods for carrying out the second tactical purpose in naval warfare; that of striking with flexibility and heavy firepower. There is the dive bomber. We made it first. Germany made it famous. We make it best. The Martin BM-1, closely followed by the Curtiss O2C-1 *Helldiver*, both of which were of 1926-27 vintage, were the first dive bombers as such to take to the air anywhere. Both the planes and the tactics in which they are employed have undergone continual refinement in the interim. Although the Nazi *stukas* made the world dive-bomber-conscious during the Spanish, Polish, and Low Countries campaigns, the Navy's four new types are now far superior to any in the world in speed, warload, range, and armament.

Then there is the torpedo plane which is doing yeoman duty in the war at sea. It is, perhaps, the flying fleet's most potent striking force. Although the British Admiralty used several types of planes for carrying torpedos before and during World War I, and they launched the first successful attack against a surface vessel late in 1915 in the Sea of Marmara, the development of the torpedo plane to its present tactical efficiency is the handiwork of the United States Navy. Until the carriers *Lexington* and *Saratoga* entered service early in 1928, the torpedo bombers were fitted with twin pontoons: since that time, they have operated from the carrier decks as wheeled landplanes.

The aircraft carriers, great floating airports on which much of the flying fleet roosts, are last, but far from least, among America's contributions to naval science. The carrier, also, is not too new an idea. Eugene Ely, Curtiss test pilot and the original member of that now highly specialized profession, in November, 1910, made a flight from a platform built on the bow of the U.S.S. *Birmingham* at Hampton Roads, Virginia. In January of the following year, Ely landed his plane upon a large platform built over the stern of the U.S.S. *Pennsylvania* anchored in San Francisco Bay. These were sensational flights, and were considered in the light of stunts rather than as practical demonstrations. After landing on the *Pennsylvania*, Ely took off from the same platform and returned to his base ashore. The aircraft carrier had been born. Authority was given the Naval Aeronautical Service, as it was then called, in October, 1919, to convert the collier *Jupiter* into a carrier, and this ship was renamed the *Langley*. Three years later, to the very month, the first landing upon a carrier deck was accomplished by Lieutenant-Commander G. deC. Chevalier. A few minutes later, Lieutenant-Commander V. C. Griffin lifted the plane from the *Langley's* deck in the first take-off from a carrier. Seven of these floating air fields are now in the commission of the United States Navy, and eleven more



Helldiver, best and fastest dive bomber; better one is under experiment

are now in the course of construction.

Navy ingenuity is not confined to these larger items; any number of important devices and much aircraft material were conceived and developed by the Bureau of Aeronautics. Included is the carrier arresting gear, very secret and said to be finest in use anywhere; flotation gear to keep both plane and pilot afloat after emergency landings; the Sperry bombing sight, which gained fame in Army hands, but which was originally built to Navy specifications; a vital process for corrosion-proofing of aircraft metals; and many important gadgets and instruments which are the brain children of the design and engineering divisions of the Naval Aircraft Factory.

WHEN the fleet goes to sea, the air force—with the exception of occasional bombing operations—remains a component of the fleet; just as much so as the battle force, cruiser force, or the scouting force. Despite its tactical importance, the air arm is but a part of the overall naval picture.

Let's take a look at this picture. The fleet is far at sea in cruising formation. ships are strung out over miles of tossing, angry ocean, one vessel barely within sight of the other. The maneuvers are worked out aboard the flagship on the admiral's chart.

Curtiss *Seagulls* (SO3C-1's) and Vought-Sikorsky *Kingfishers* (OS2U-2's) are shot from the catapults of the dreadnaughts and cruisers. These scout-observation planes sweep ahead of the fleet to spy out the movements of enemy vessels. They are joined by Brewster *Buccaneers* (SB2A-1's), Curtiss *Helldivers* (SB2C-1's), Douglas *Dauntless* (SBD-3's), and Vought-Sikorsky *Vindicators* (SB2U-2's) from the carriers. These latter four types of craft will stop scouting and commence bombing when the enemy is sighted; they are designated as VSB scout bombers but go into action as dive bombers, which they are insofar as design and armament is concerned. Radio contact reports from the other observation planes to the flagship greatly facilitate the "chart maneuvers" by keeping the admiral and his officers informed of the goings on. When the engagement starts, these scouts will also maintain contact with the "spotters" and "plotting rooms" of their respective ships to aid in range correction, thereby defeating the purpose of the enemy's smoke screens, which are intended to conceal vessel movements and formations.

Meanwhile, the carriers' other planes are taking off. Crack fighters streak off to engage those of the enemy. Big, fast torpedo bombers such as the Douglas *Devastators* (TBD-1's) and Grumman *Avengers* (TBF-1's) roar away to strike at the hostile main body. These craft carry either torpedos or large bomb loads, depending upon the circumstances. Higher up in the now smoky sky are the "big boats," the patrol bombers that have come forth from distant mainland or insular bases. These include the giant Consolidated *Coronados* (PB2Y-2's), *Catalinas* (PBY-5's), and Martin *Mariners* (PBM-1's and PBM-2's).

The Naval Air Service's position of pre-eminence is due largely to this sparkling array of aircraft, many of which have proved themselves nobly in service with Britain's fighting Fleet Air Arm. Brewster and Grumman fighters have bested the vaunted Nazi Messerschmitts on many occasions, as well as the best craft Italy can put into the air. The *Catalina* boats have done yeoman duty in the Mediterranean, and it was one of these ships—with an American observer aboard—that spotted the *Bismark* after 1941's greatest sea hunt. The Grumman F5F-1 and Vought-Sikorsky F4U-1 are among the world's six fastest fighters; and none of the other four are naval craft carrying the many extras demanded by over-seas operations. The naval expansion program calls for thousands of these crafts, the total to include the highly essential trainers and utility airplanes. The largest naval air arm in the world for several years, our flying fleet is rapidly growing even stronger wings.

This speedy growth necessitated the immediate training of thousands of pilots, navigators, bombardiers, gunners, flight mechanics, and ground personnel. Like the planes they fly, our naval airmen have long been regarded as the best trained anywhere in the world, and this is the result of the philosophy of "naval aviators for naval aviation"; these young men are flying sailors rather than sea-going fliers. The time spent in learning about things nautical and becoming accustomed to maritime practice pays big dividends. Without this specialized training, the fliers would be unable to identify types of warships, or distinguish between theirs and those of the enemy; they would be unable to interpret certain tactical maneuvers they might observe from above or to carry out numerous other duties requiring sea training, such as scouting and search problems.

THE Naval Air Stations at Pensacola and Jacksonville, Florida, and Corpus Christi, Texas, are bearing the brunt of the training of the new pilots called for by the expansion plans. The flying cadets enter one of these three schools with the rank of seaman, second-class, after they successfully complete a 30-day preliminary course at one of the several Naval Reserve Aviation bases throughout the country. Advanced training for carrier flying is conducted at the Miami Naval Air Station for graduates of the three larger schools who are to specialize in this type of work. The regular one-year courses at Pensacola, Jacksonville, and Corpus Christi have been cut to seven months duration in order to step up the training program, but the change does not result in a reduction of flying time.

The embryo aviators still receive about 225 hours of flight instruction, and are better equipped to fly one particular type of plane than they were under the full-year training scheme. This has been made possible through specialization: If the cadet is chosen for

fighter duty, he begins his training in landplanes and, upon completion of his advanced work, flies older fighter types. Cadets chosen for other carrier branches—scouting, dive bombing, torpedo bombing—follow a similar course. Only the selectees for battleship and cruiser seaplane duty and those for patrol work receive seaplane training; formerly, all Navy pilots flew seaplane trainers during the primary phase of their instruction. Upon completion of the courses, the cadets receive their hard-earned gold wings and Ensign's commission. Post-grad work, a sort of aerial internship, involves further training and seasoning with tactical squadrons of the Fleet.

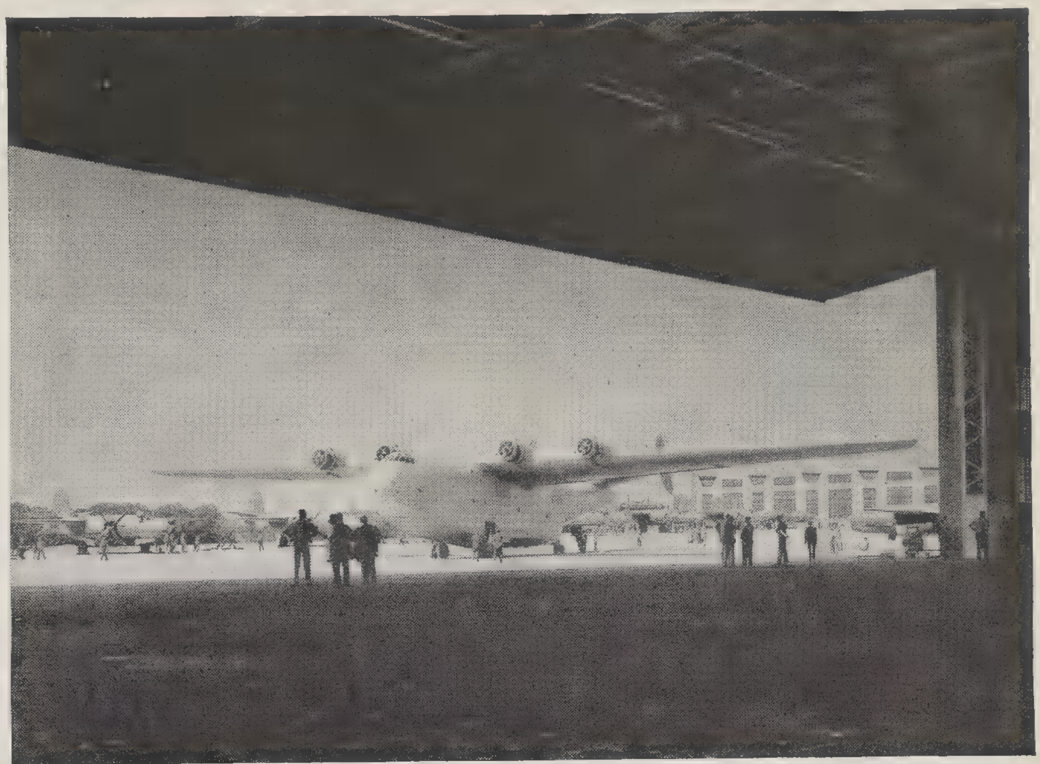
Back of the pilot training program are crew members, mechanics, and additional ground personnel who "keep 'em flying." Enlisted men enter the many Navy trade schools to receive one-year apprentice courses, after which they go to naval station overhaul bases for further training. Officers are afforded special courses at the Naval Academy and certain colleges and universities that have to do with areonautical engineering, naval architecture, and meteorology. When the flying fleet is at work a thousand or two miles from the nearest base, this Navy personnel must make repairs and perform the necessary engine, aircraft, and accessory checks without the help of the specialists normally available at a large base. An operational unit carries with it engine and aircraft mechanics, metal workers, carpenters, radio technicians, armorers, and so forth. The squadron engineering officer—who is usually a graduate aero engineer as well as an experienced naval pilot—must know not only operating maintenance but also the practices and methods of repair maintenance. Each of the carriers and seaplane tenders has extensive shops and laboratories available for this overhaul work.

Gunners, also, are usually mechanics, and these men are trained at the San Diego and Norfolk air stations. Bombardiers and navigators are trained at the Miami school.

The Naval Air Service must have bases from which to operate. The expansion has already increased stations and airdromes from the seven shore establishments in 1939 to more than 30 major bases, and, in addition, several auxiliary bases. All the new stations and bases in the Western Hemisphere will be in operation by the time this is in print: these extend from Iceland and Greenland down to Georgetown, British Guiana; from Alaska down to Honolulu.

Before this war is over, the Navy will undoubtedly have an opportunity to prove that its planes, the men who fly them, and the tactics in which both are employed have no equal in the world. Secretary of Navy Knox phrases it best in his own words:

"Since the invention of the airplane, our Navy has used more aviation than any other major power, has put aviation to more uses in co-ordinated combat, including bombing and observation. It is a tribute to the officers and men who run our Navy that the lesson of sea-air power in World War II bore out a theory they had already put into practice."



Large Navy flying battleships have high-speed, long cruising range

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WATER 'CHUTING

Marines Use Gas Inflated Jackets

An interesting and additional note on the training of Marine parachute troopers, supplementing the detailed description published in our January issue, has to do with water jumps. When United States' sea soldiers are forced to "have the situation well in hand" by an attack from plane carriers, provision is made for landing the parachutists in the water.

For this work the Marines are equipped with inflatable rubber jackets under their 'chute harnesses. As the parachutist approaches the water, he slips out of his harness while still 10 or 15 feet above the sea and drops into the water. Freed of the weight, the 'chute drifts away so that as the Marine rises to the surface after plummeting into the sea he is not likely to be smothered by having the silken canopy land directly above him. Meanwhile, the Leatherneck paratrooper must remember to release the toggle on a small, metallic cartridge—much like the one used in a charged water bottle—which is attached to the mouth of his deflated life preserver. The cartridge is charged with carbon dioxide and blows up the rubber jacket, helping the 'chutist to rise to the surface, and to remain there.—*A. D. R., IV.*

FLUORESCENT

Fabrics for Use In Blackouts

Workers in factories and pedestrians in traffic can be made visible during blackouts by fluorescent-dyed clothing and ultra-violet lighting. Clothing dyed with fluorescent colors glows in invisible ultra-violet light—permissible in blackouts—with a subdued radiance bright enough to be seen nearby but too weak to be visible at a distance, even in a blackout otherwise complete. In blacked-out plants equipped with ultra-violet lamps, workers wearing such garments are readily visible to their associates.

Traffic control during blackouts can be effected by using ultra-violet lamps in traffic lights and in the headlights of vehicles. In the invisible radiance from these lamps, clothing dyed with fluorescent colors glows brightly enough to make persons wearing it visible to drivers or other pedestrians but not to aviators at a distance.

Dyes of many shades, possessing fluorescent properties, are available for

Left: **Fluorescent-dyed clothing in light and,** ***right,*** **in the darkness**

application to various textile fibers and fabrics, according to officials of the Calco Chemical Division of American Cyanamid Company. In ultra-violet light, they give fluorescent colors varying from violet through blues, greens, yellows, oranges, and browns to rich reds.

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AIR CONDITIONING—In protecting power and equipment, in speeding the production of thousands of articles of defense machinery back of the lines, and generally in helping men and machines to work better, air conditioning is month by month increasing its service to the all-out war efforts of the nation.

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OVERPASS

For Speeding-Up Cross Traffic

BRIEFLY referred to in the article on the army engineers, "Builders For the Army," published in our issue of December 1941, was "a portable overpass invaluable when one column of troops must cross another's line of march." Such a portable overpass has also been developed by R. G. LeTourneau, Inc., which not only has military implications but also can be brought into service during especially heavy traffic periods or can be left permanently in one location for civilian use.

The portable overpass, shown in one of our photographs, consists of three 60-foot sections with detachable legs having adjustable piers to fit any site contour and provide the required clearance for under-crossing traffic. Rigidly built of alloy steels, arc-welded throughout, the overpass incorporates box-beam side girders and floor joists and a solid steel floor plate. It is claimed that it can be assembled and ready for use in as short a time as two and one-half hours. When the overpass is to be moved to another location it can be carried by a two-ton truck-trailer outfit or on railroad flat cars.

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RESPIRATORS—The Chemical Warfare Service of the United States has recently received delivery of 100,000 respirators which weigh only one and a half ounces and yet will exclude dust particles as small as 1/25,000 inch in diameter.

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CURTAINS

For Blackouts: of Wool, Paper

"BLACKOUT" requirements at present are puzzling many people in all sections of the country. Due to the heavy demand for appropriate material for such use, shortages have occurred in some localities. The Felt Association, Inc., stated recently that it had been noted that many people do not realize the adaptability and advantages of wool felt, an available commodity, for blackout curtains. Ordinary light will not penetrate felt of suitable grade, and it may be readily used for window shields for office buildings, power houses, water works, and other types for factories and defense plants working night shifts. For windows in homes, felt is practical, as it can be tacked, glued, or pasted in almost any form without tearing, and can be cut to shape without ravelling. It also may be attached to shade curtain rollers, replacing the usual shade cloth. Colors—brown, green, navy and dark blue and olive drab—are just as satisfactory for the purpose as black, and of course are more desirable from the interior decorator's standpoint. Felt may be flameproofed and mothproofed.

Another material that has been proved satisfactory for "blackout" use in the home and factory is Sisalkraft. This sheeting has been war tested in England since 1939 and it is still being used today. It has been approved by the Air Ministry, Admiralty, War Office, H. M. Office of Works, Ministry of Home Security, and other departments of the English Government.

One reason that Sisalkraft is effective for blackout purposes is that it is composed of two sheets of kraft paper cemented together with two layers of asphalt and reinforced with sisal fibers. This composition makes Sisalkraft opague, strong, pliable, and, above all, highly reflective, so that a factory using this material as a blackout does not need any additional power for lighting, whereas black cloth absorbs light and painting prohibits the use of daylight. Sisalkraft can be used as a screen on wood frames, made to fit the window opening tightly, or as a roll curtain. In England they have found that a 9-inch overlap on the sides of the windows is essential when used as a curtain. Sisalkraft reflects approximately 70 percent of the light that impinges on it, and, furthermore, the material can be rolled up or removed during the day, thus permitting the use of natural light.

Expedites traffic movements, both military and civilian

Rolling Off a Log

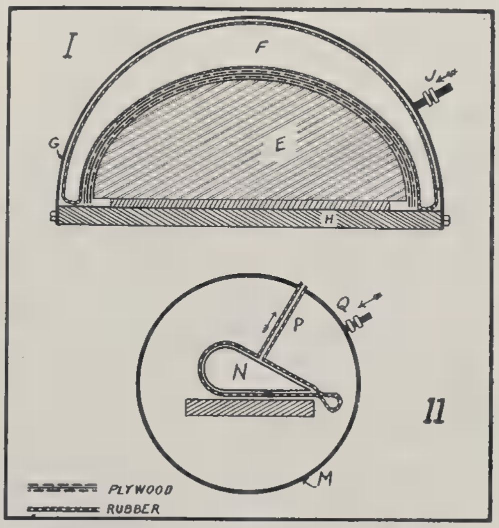
Plywood Made Available for Many New Applications by Development of Synthetic Adhesives

THOMAS D. PERRY

PLYWOOD, which consists essentially of layers of veneer bonded together with adhesive, is an ancient material that in very recent years has been freed from former limitations to an extent making it of pronounced value to defense activities as well as to normal peacetime uses. Limitations on the use of plywood have always been those of the available bonding agents and the technique of using them. Until the practical development of synthetic resin adhesives during the last ten years, many fields of possible application were barred to plywood by the inferior durability of conventional glues. Now, with dependable bonding agents, plywood not only is meeting what might be termed its logical uses but is being put to work in unexpected fields, where it can satisfactorily take the place of less generously available materials, such as the lighter metals.

The rudiments of modern plywood construction—that is, with the grain of alternate layers at right angles—were first recognized between 1830 and 1840, in piano pin planks made of sawed veneer. The purpose of the cross layers was to insure a firm grip of the wood fibers on the shank of the tuning pin, so that after many years of twisting, the grip would still be firm and no signs of splitting would be manifest in the wood.

The making of cross-laid veneer products began to emerge as an industry early in the 1880's but grew rather slowly until about the beginning of World War I. The unusual ratios of strength to weight in plywood attracted the attention of the early aircraft engineers, who used plywood extensively in the primitive aircraft of that time. One of the handicaps to the new industry was the terms "veneer," "veneered," and "veneering," which suffered from somewhat sinister dictionary definitions. Manufacturers, trade associations, and government agencies joined in the search for a better name. The author well remembers the earnest discussions of those days, resulting in the choice of the term "plywood," which has since become the standard description of basic veneer assemblies. It had been an obscure technical term, little used and less understood, but has come to carry its new responsibility most efficiently. Plywood is a product made of veneer, as shoes are made of leather, as machines are constructed of iron and steel, as houses are built of wood and masonry, and as cloth is woven from thread and yarn.



Courtesy Institute of Aeronautical Science

All-directional pressure for bonding plywood structures, as in forming half-fuselages, is secured by the flexible-bag method. I: Bag F is inflated through J and restrained by shell G, attached to base H. Mold E (metal or wood) is recessed for frame members; veneers thus are bonded into plywood and plywood is attached to frame in one pressure application. II: Bag encloses aileron N, temporarily fastened together. Bag is deflated through P, which remains as a vent. Tank M is filled through Q, imposing external pressure through the bag on the aileron, fabricated of plywood

Serviceable plywood requires a suitable quality of veneer and a dependable adhesive. The older conventional glues—animal, casein, vegetable, and soybean—had their good qualities and would render acceptable service under ordinary conditions. When subjected to severe heat, moisture, and exposure to weather, however, none of them would withstand prolonged service, and, as a result, the use of plywood was restricted to moderately protected locations. Plywood made with the old glues was, of course, often blamed for failures that were caused by unintelligent adaptations.

During World War I, both cold-pressed casein and hot-pressed blood albumin were used in airplane construction, as they were then the best-known water-resistant glues. Both were of limited durability, were attacked by molds and fungi, and would deteriorate under severe exposure. The inadequacy of these glues, coupled with the vigorous promotional efforts of the rapidly developing aluminum industry, more or less sidetracked the use of plywood for aircraft. As a consequence, the airplanes of the succeeding 20 years were largely made of the lighter metals.

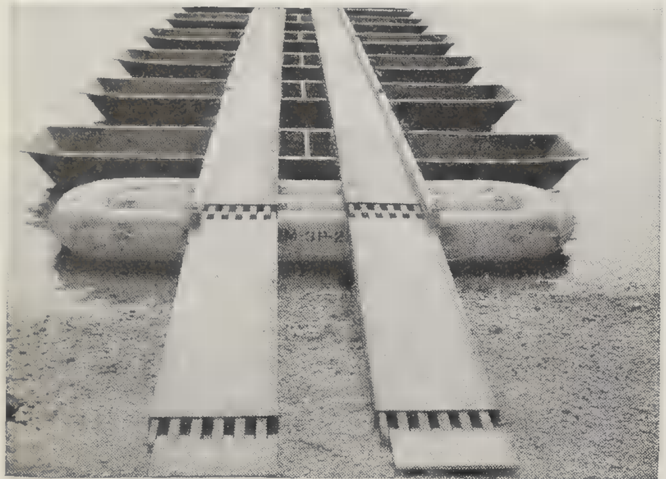
IN THE early 1930's resin adhesives were little more than interesting laboratory experiments, but of definite promise if their cost could be reduced. Around 1935 a phenol formaldehyde resin film, from domestic sources, became available at reasonable cost. It required curing, or hardening, under simultaneous heat and pressure, and the bond was irreversible; that is, it would not weaken or deteriorate from heat, moisture, or fungus. In durability, the bond would outlast the wood itself. It was soon recognized to be an adhesive with such service characteristics as to make plywood fully available for aircraft and boats. Supplementary to this resin film were a number of other resin adhesives, both urea and phenolic, with similar service qualities. The ureas were not quite so durable as the phenolics but could be cured even at room temperatures. The phenolics, which equaled the first film in durability, became available in liquid and dry forms for a wider range of applications.

Veneer is the raw material, direct from the tree or log, from which plywood is assembled with a suitable adhesive. Over 90 percent of the veneer used is rotary-cut on a lathe, much as paper is unrolled. Sliced veneer is cut similarly from the flat side of a log segment, but can be no wider than the log. The cutting of rotary veneer gives much higher log yields than does sawing into lumber. Veneer is used, of course, for many products other than plywood, such as fruit and vegetable containers, hand baggage, and so on.

Since wood is strong lengthwise and weak widthwise, the crisscross structure of plywood, offsetting this widthwise weakness, imparts to the material

Courtesy *Technology Review*, from which the present text was slightly condensed. The author is Sales and Development Engineer of the Resinous Products and Chemical Company and author of a book entitled "Modern Plywood."

substantially equal strengths in both directions. The original strength of the wood is reinforced by the adhesive, so that the aggregate strength of the integrated plywood is greater than the total strength of the veneers composing it. Plywood in its simplest form, three-ply, has two outer layers with parallel grain, each half the thickness of the center layer, or core, which has its grain at 90 degrees to that of the faces. The result is what is called a balanced construction.



Courtesy Plyweld

One application of the ultimate product of the process of rolling off a log. This experimental plywood ramp, developed by the United States Army, will carry large loads. The individual sections are quickly joined at their finger-like ends with pins and are easily transported by Army trucks to the point of use

Another common construction is five-ply, in which the strength of the wood fiber may be equalized in each direction, or in which a thick lumber core may be used to give a dominant strength in the direction required. In the standard five-ply type, the cross layers between the core and faces are called "crossbands." Crossbands of 1/16 inch will give adequate stability to plywood one inch thick.

Multi-ply constructions, seven, nine, eleven, thirteen, and so on, are often used when strength distribution and durability factors are important, as in aircraft and boats. An even number of plies is seldom used, as it results in an unbalanced construction and tends to cause warping and twisting. An exception is two-ply, which is often made for curved work, where the reinforcing of the double layer reduces the hazard of rupture of the veneer during bending. Two-ply is seldom an ultimate product but is, rather, an intermediate step toward the manufacture of a higher ply.

Laminated wood, a term used to describe a veneer construction in which all layers are parallel, is usually made in plywood factories. Its purpose is to maintain lengthwise strength and stiffness, which are sacrificed in standard plywood constructions. In fact, laminated wood is stronger than normal solid wood of the same dimensions, because of the overlapping of the slightly angling wood grain.

Generally, the thinner the veneer layers, the stronger the plywood or laminated wood. Veneer can be cut as thin as 1/100 inch, but economic considerations prevent the extensive use of veneer thinner than 1/40 inch.

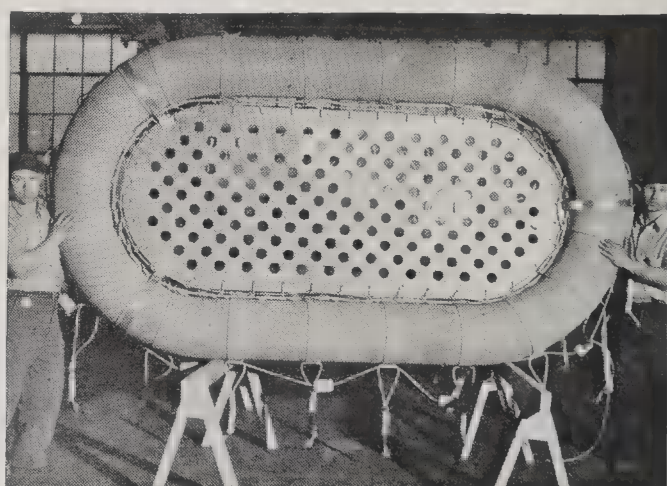
The applications of plywood rely upon qualities peculiar to the material, which may be summarized thus: The strength of plywood may be distributed equally in both directions, whereas normal wood has a predominant strength in one direction only. Plywood cannot be split, because of the holding power of its adjacent layers. The shrinking and swelling of plywood, under exposure to moisture, are relatively slight. Wood does not shrink appreciably endwise, and the widthwise veneer is held to stable dimensions by the immediately adjacent endwise layers. This factor reduces warping far below that of normal solid wood. After gluing, plywood can be bent and curved to a much greater extent than normal wood, because of the reinforcing effect of the neighboring layers. The limber veneer layers can also be bent during bonding, when they easily slip by each other but are sturdily held in the curved position by the adhesive. The strength-to-weight ratios of plywood are exceptionally good, especially for aircraft and watercraft.

Consideration has so far been given to normal plywood, in which wood compression is nominal and only enough to bring the veneer surfaces into close contact. If greater pressures (500 to 1500 pounds and even higher) are exerted, the veneer is compressed into a high-density plywood with a larger amount of wood fiber per square inch of cross section and a proportionately greater increase in strength. If the veneer layers were originally 1/30 inch thick and are compressed to 1/45 inch with a resin adhesive between them, a substantial amount of resin impregnation occurs. A 50 percent increase in material will double both tensile and shear strengths.

Several types of high-density plywood are made, depending on the ratio of wood fiber to resin, on the pressure exerted, and on the kind of resin used. A phenolic resin film can be employed to give a product which is essentially wood reinforced with resin, with wood characteristics predominating. The film process is simple, and the amount of resin can be controlled by the thickness of the veneer layers.

Another method for high-density work, which produces what is referred to as "impregnated wood," forces liquid phenolic resin into the voids of the wood fiber, and then, after reducing the solvent content by predrying to avoid blisters in hot-pressing, compresses the whole in a hot-press, as with the resin film. The result is a resin reinforced with wood fiber, in which resin characteristics dominate. The resin content is considerably higher (of the order of 30 to 10) than in the film product, and water absorptive capacity is less. Both products are affected far less by moisture than is normal wood or plywood.

An interesting development of high-density plywood is that of variable-density construction. Here more layers of veneer are used at one end than at the other and the whole assembly is compressed to an even thickness, resulting in greater compression and higher density at one end.



Courtesy Bristol Aircraft Corporation

Laminated lumber and plywood in a life raft. The ring is made of balsa wood, resin bonded, doweled, and tightly wound with canvas strips. The floor is perforated plywood. Ten by five and a half feet, the raft accommodates 25

The ability to predetermine density and strength gives to designers of plywood structures a facility that exists with few basic materials. While this procedure can be compared with the alloying and heat-treatment of metals, it has an even wider application range.

Plywood lends itself efficiently to forming and shaping. Attachment or connector clips made of plywood are easily bent and bonded between pairs of heated metal dies. These clips and braces can be made of normal or high-density plywood, depending on strength requirements. The use of them, with adhesives, in constructions involving plywood-to-plywood or plywood-to-frame members, reveals one of the marked advantages of plywood over the metals. Riveting, spot welding, or strip welding must be employed with metals, whereas the clips or braces used with plywood can be glued over their entire area and supplemented, if necessary, with mechanical fasteners to maintain pressure until the adhesive gets its initial grip. Rivets are costly, the installation of them is time-consuming, and the irregularities of the resulting surface are most unfavorable in air or water currents. Glued plywood provides the smooth streamline surface, strongly attached to its framework, which is so essential in aircraft and boats. This forming and shaping can be done best in heated dies, using thermosetting resin adhesives.

One of the newer techniques in the plywood industry, although it has been used in rubber vulcanizing for years, is the flexible-bag method of applying pressure. A distinct advantage of this process is its quality of fluid, or all-directional pressure—in other words, the pressure is perpendicular to all flat or curved surfaces within its range. This fluid pressure can be exerted in a number of ways and the fluid-pressure medium can be air, steam, hot water, or a combination of them, the chief problem being rapid application.

The assemblies on which the technique is usable can be of veneer or of two-ply, of such widths and shapes as will make tight-fitting joints without overlapping. In the half-fuselage shown in one of the drawings, the inner strips of veneer are longitudinal and tapered like barrel staves, the center layer is of moderately wide half hoops, and the outer layer is parallel to the inner layer. If a boat hull is to be made by this process, large two-ply sheets are customarily used, with V's, or gores, cut to permit proper curving or tapering of the layers. In an aileron, the skin covering may be made of either veneer or plywood, often laid at an angle of 45 degrees to the axis of curvature and temporarily attached to the inner framework until the adhesive acquires its grip. These are only two relatively simple constructions using resin adhesives of the phenolic type; many others employ combinations of these processes and apply flexible pressure in other ways.

Courtesy Plyweld

An experimental plywood towboat for the United States Army. It has an overpowered engine and marked qualities of maneuverability. Special rails for handling the boat in and out of the water are shown in illustration

The flexible-bag process permits making shell or monocoque constructions of an infinite variety of shapes and range of complexity. The method may be compared to the drawing of metals between pairs of dies, but it has the distinct advantage of resulting in a product that is more nearly free from internal stresses than is drawn metal. It is also true that plywood can be molded into many complex shapes which are beyond the practical range of drawn metal.

Well demonstrated is the fact that resin adhesives have definitely greater durability when cured with heat than when cured with chemical reagents. For plywood constructions up to an inch in thickness, the surface application of adequate heat is entirely practical. For assemblies several inches thick, other methods of heat application are imperative. The most satisfactory solution, so far, is to put the clamped plywood assembly in a high-frequency electric field of some five million alternations each second, provided by flat metal electrodes which are insulated from the metal parts of the press and are placed at the bottom and top of the assembly and within the press. The heat thus generated raises the temperature of the assembly within the field to the point necessary to polymerize the resins. The lines of resin adhesives are found to be some 20 degrees hotter than the adjacent wood, which is a favorable gradient that does not tend to dry the wood excessively. Other than this differential, the entire assembly in the field is heated instantly and the cure of the resin can be effective in a matter of minutes, depending on the intensity and capacity of the field.

Applications of plywood which are becoming increasingly important in the defense program are more readily visualized with these recent developments in perspective against the contrasting background of earlier limitations. Airplanes are one of the major products in which plywood can be of substantial importance in the present defense program. Perhaps the most obvious way in which plywood can serve the airplane builder is that of skin covering for the wings, tail parts, rudder, ailerons, stabilizers, and the like. Here the external streamlining of plywood, combined with its factor of stiffness to weight, gives it advantages over thin metals, which require riveting and welding and are less able to resist the aerodynamic forces without buckling and vibrating. The multitude of ribs and framing members required to support metal facings can be substantially reduced in constructions where several layers of plywood covering are superimposed for stiffness, all within permissible weights and strengths. Adequate resin adhesives are available for both the plywood bonding and the assembly operations. Plywood wings are now extensively used in military training ships.

Plywood fuselages, of molded monocoque shapes, have been made and flown successfully. Molded noses and nacelles, from plywood, are in actual production for several types of Canadian fighter planes. The chief drawbacks here are the lack of scientific strength-data and the formulas essential for efficient design.

Spruce spars are almost universal in smaller planes, yet solid spruce is scarce and costly. Laminated spruce is stronger than solid spruce, easier to obtain, far more uniform, with greater yield from the log. The chief problem in the use of spruce spars is that of attaching them to the fuselage and the landing gear; normal spruce has relatively low bolt-holding power. Solution of this problem is offered by high-density plywood with raised, or embossed knobs on one side. The knobs can be pressed (that is, drawn by bolts) into the lighter and softer spruce and firmly glued in addition. These high-density plywood attachment plates distribute the load transmitted from the landing gear, over as large an area of the spar as is necessary. Not only do they serve to reduce the use of metal but they can be made by woodworkers on woodworking machines, both of which are far more plentiful than the corresponding facilities in the metal field.

Propellers need to be sturdy at the hub, where weight is not objectionable, and light in weight at the tip, where centrifugal forces are serious. Variable-

density plywood meets these requirements and gives to the blade the resiliency of wood and the excellent fatigue characteristics of wood. Propellers so made are extensively used in England. These adaptations of plywood to airplane construction refer specifically to the smaller and lighter planes, including perhaps all types of training ships for military aviators. Experience must be gained in these smaller units, so that changes from metal to plywood in the larger planes may be based on actual demonstrations of serviceability under severe conditions. For the present, many non-stressed parts of the larger planes, such as bomb-bay doors, instrument boards, manhole and handhole rings, covers, doors, floors, and the like, may be safely made of plywood. An ingenious ribbed plywood floor, combining great stiffness with light weight, has recently been patented.

In large seagoing vessels, plywood has established a distinct place for itself in partitions and bulkheads. Crossbands and faces are glued to a lightweight asbestos core, providing fireproofness together with attractive and noncorrodible surfaces. Plywood can also be made with metal faces, or metal inner layers. Curved and rounded partitions can be made of plywood of still different constructions.

MANY smaller vessels, such as destroyers, Coast Guard cutters, and the like, are designed with plywood bulkheads, dividing the boat into many compartments, for safety. Such bulkheads also serve as important strength members in the boat structure. They are lighter and more resistant to the elements than is metal, more free from shrink and swell than is solid wood, and far less prone to cracks and leaks. Plywood sheets up to 80 feet long by eight feet wide have been made for the hulls of such boats and are now in production. Several layers are used on the hull, with staggered joints. For the superstructures on such watercraft, streamline housings of molded plywood are beyond the experimental stage and may soon become standard.

The utility of plywood in boats increases as the size of the boat decreases. For boats 20 feet and under, thousands of hulls have been made by the flexible-bag molding process. Ribs and framework can be substantially reduced and often eliminated. Angling strips can be placed inside to serve as bracing members. Plywood for such boatwork is usually made in two-ply sheets, several layers being used to add up to a total thickness of ½ inch and more. These boats are far lighter and sturdier than those of the conventional construction, and the problems of shrinking and calking are practically eliminated.

Another interesting development is a pontoon molded from veneer and plywood. It weighs far less than sheet metal, so that fewer men can handle the units and truck-carrying capacity is multiplied several-fold. These pontoons are clamped together to support the runways of temporary pontoon bridges. The pontoons nest on the truck bed and require a height of less than one foot per unit. Ramps, or walkways, for use in pontoon bridges are also being made of plywood. Life rafts and towboats are other applications of the material.

Periodic rumors are heard that the supply of black-walnut lumber for gun-stocks is inadequate; in any event, the elapsed time from the green tree to the seasoned blank is unreasonably long. Plywood has been tested and found adequate, and is much more quickly available. Several species of veneer, pressed to the desired density, can be used.

When made of solid lumber, army lockers for soldiers' personal possessions are heavy and likely to develop unsightly and untidy cracks. With metal lockers, moreover, rust, corrosion, and denting become serious problems. Waterproof resin-bonded plywood hence has been used extensively in recent contracts.

Other uses of plywood, common to both civilian and military life, include concrete forms, prefabricated houses for defense workers and for military cantonments, furniture for living quarters and for offices, truck bodies, profiles for shipbuilding, patterns for foundry work, industrial buildings and equipment, partitions, and many other products.

Those who have studied the many problems involved in the intelligent use of plywood are becoming more keenly aware of the fact that it cannot be adequately evaluated and utilized according to the experience and knowledge gained from the use of metals. Wood and plywood have qualities and advantages that frequently are quite different from those of other materials. Certain tasks can be performed better by metal products, others by units made of veneer and plywood. In no sense is one a substitute for the other. The skilful combination of both materials will result in an effectiveness, a suitability, and an economy that cannot be secured by either alone.

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Duplicating Without Dies

Short-Run Production Requirements in Metal Shapes Met by Ingenious Hand-Operated Tools

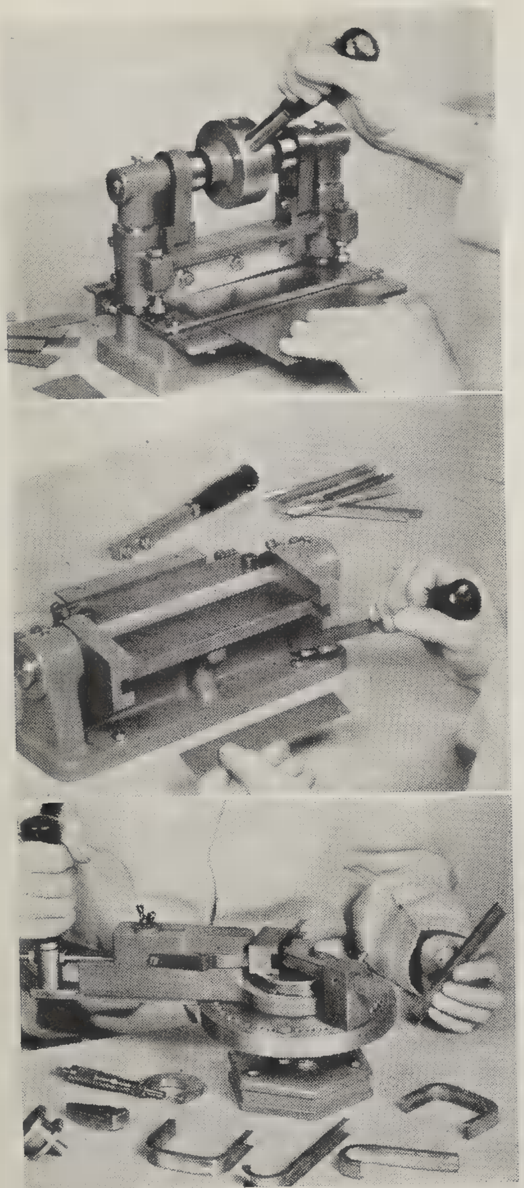
A. P. PECK

A MID-WESTERN manufacturer had closed a contract for 400 medium tanks for the British government. Hence the plant would require 400 each of various types of eyes formed on arms and links for operating engine and turret controls. Also needed would be 400 each of specially shaped angle brackets for panel and dashboard mountings and a variety of other metal forms, each in multiples of 400.

Under ordinary circumstances these production requirements would be filled by means of a series of special forming dies, with consequent loss of time while the dies were being designed and made. Then, when the job was finished, most of the dies would probably be worthless for other purposes, after having been used for only 400 operations. Not only would the time element militate against the use of dies, but the cost would be out of proportion to the results.

Such production problems, not unusual under present-day circumstances, can often be solved by the use of a

Hand operated "production line"



Close-ups of the unit tools shown in the illustration on the opposite page. *Top to bottom:* The shear, the brake, and the bending device. To the left in the bottom picture are shown the two parts which are used for converting the unit for forming either right or left-hand radii with the side members turned out instead of in

series of hand-operated duplicating tools which turn out precision work for short metal runs and for experimental development projects. These tools, known by the name of Di-Acro, include a bench shear, a brake to produce non-stock-size channel and angle forms, and a bending unit which can produce a wide variety of curved and angle forms from any ductile metal, the range of contour bending being limited only by the expansion and contraction limits of the material being formed.

One of our photographs shows a shop "production line" using these hand tools. In the background one operator is shearing stock material to correct size. The worker in the center is using the brake to create the required angle in the sheared material, while the third operator is bending the angle members in right- and left-hand radii as called for by specifications. On the bench in the foreground are a variety of the shapes that can be produced by the bender through simple adjustments of the mechanism—adjustments that can be made by any ordinary apprentice-machinist and do not require the skill of a tool or die maker.

Since these tools are designed to produce duplicate shapes with the same accuracy as can be obtained with blanking or forming dies, it is obvious that the tools themselves must be of precise construction and provided with accurate stops that will make possible working within the ordinary tolerances of die accuracy.

The shear in the "production line" illustrated is designed to meet the requirements for a machine that will fit into industrial operations between the heavy floor-type foot-operated shear and the small thumb-and-finger "tinsmith" shear. By means of adjustable stops it can be set for die duplicating work, for trimming metal stampings, and for working stock size materials. The operator of the shear has close observation of his work at all times; the hand-operated lever provides a sensitive cutting control, yet the stability of the device makes possible accurate light shearing.

The brake device fits into the industrial picture in the same manner as the shear—between the floor-type brake and the hand-operated vise and pinchers. Angle and channel forms can be produced in sizes from ⅛ inch upward and other types of folds can be accomplished to 110 degrees of radii.

The bending unit is a basic type of machine which will duplicate many varieties of metal pieces throughout a wide range of contour bending. The unit will receive without alteration to its design simple conversions for forming angle, channel, rod, round or square tube, round, square, half-round or flat wire and strip stock (flat or on edge).

As noted before, these units are designed for co-operative application to short metal runs, producing by hand an accurately duplicated run of pieces long before conventional blanking or forming dies could be completed for regular operation. Thus they can be applied either to a complete job, as in the case of the 400 tanks mentioned, or can be used as stop-gaps to fill in between the completion of a design and the completion of forming dies, where the ultimate aim is high-speed mass production. In such a case these hand-operated units will permit actual production to start much earlier than would otherwise be the case.

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TELEPHONE SAVINGS

Reclamation And Substitution For Conservation

A SAVING of more than 5,000,000 pounds of metals vital to defense needs including enough aluminum to build more than 275 fighter planes, or half as many bombers, was effected during 1941 by the Bell Telephone System through a materials substitution program.

In addition to such savings are the reclamation activities which the Bell System has been carrying on since 1931. At Tottenville, on Staten Island, New York, its reclamation unit, the Nassau Smelting and Refining Company, last year supplied the System with more than 42,000,000 pounds of metal, obtained chiefly from non-ferrous metals in outworn equipment, structures, and supplies junked by telephone companies. The amount thus junked in the course of a year totals upwards of 100,000,000 pounds, three-fourths of which is in metals.

How to make the most effective use of materials, particularly of new materials as they become available, has been under study by the Bell System since 1925. Immediately after the outbreak of the present war in 1939, a survey was made of critical materials used in making telephones and telephone equipment, and the determination of suitable substitutes was undertaken. With this advance preparation, the System is now able to make various substitutions in ways that interfere as little as possible with the continuation of first-class service.

The substitution program is made possible by long range planning, research by the Bell Telephone Laboratories, and readjustments in manufacturing by the Western Electric Company, manufacturing arm of the Bell System. These efforts diverted for defense use in 1941 nearly 1,700,000 pounds of aluminum, about a third of a million pounds of nickel, more than 3,000,000 pounds of zinc, and 8300 pounds of magnesium.

An example of substitution is the use of steel instead of aluminum in making the "finger wheels" in dial telephones. In this item alone the Western Electric Company is now saving about 65 tons of aluminum annually. The use of zinc is being materially reduced by coating much of the hardware used on telephone pole lines with lead instead of putting these products through a galvanizing process.

With the need to conserve rubber,

Western Electric planned to be using 20 percent less of this material by the end of 1941, chiefly by using more reclaimed rubber and careful use of materials having similar properties. For some materials research engineers have not yet found working substitutes. For instance, there is no known substitute for the zinc electrode in a dry cell. Other materials in telephone manufacture which are rapidly approaching the critical state are phenol plastic, phenol fiber, and silk.

The telephone companies throughout the country have an important part in the effort to conserve materials. Their engineers point out that protection against raw material shortages is in normal times merely a matter of good "industrial housekeeping." But now such protection is vital to defense itself.

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STEEL—Over half a million tons of steel were bought in 1940 by American housewives through their purchases of refrigerators, kitchen ranges, and washing machines, the American Iron and Steel Institute has estimated.

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ALUMINUM CLAY

New Process Opens Vast Sources of Light Metal

A NEWLY discovered process for the economical manufacture of aluminum from clay instead of bauxite was announced recently by Professor Arthur W. Hixson of the chemical engineering department of Columbia University. It is believed that the process may hold the key to United States independence of foreign sources of bauxite.

Developed at Columbia under the direction of Professor Hixson, assisted by Ralph Miller and Ivan J. Klein, the process consists of digesting selected high-silica clay with hydrochloric acid and decomposing the resultant product to obtain hydrochloric acid and aluminum oxide, or alumina. The aluminum metal is then produced electrolytically in the conventional manner.

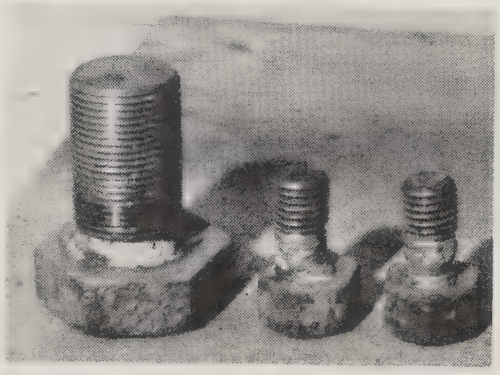
Quoting Dr. Hixson: "All present day processes for the production of aluminum utilize only high-grade ores, which consist of the mineral bauxite. The government's defense requirements for aluminum will soon exhaust the available supplies of bauxite in this country, with the result that the United States will soon depend entirely on imports for this important material.

"The economic feasibility of the new process results primarily from two things: First, the process utilizes a new technique never before employed in the metallurgical field. Secondly, it makes use of recently developed materials of construction and chemicals which are abundantly available because they are by-products of processes operated on very large scales."

BROKEN STUDS

Removed by Unique Use of Welding

A KNOTTY problem often encountered by mechanics and machinists is the broken stud bolt, a problem that has been solved by an unusual application



Extraction rate: about 20 per hour

of welding. After a year's test by welders William F. Kramer and Alex F. Morton, the method was found 20 times as fast as the previous procedure involving drilling.

The new technique involves the use of arc welding. When a series of stud bolts are sheared off in a casting, the welders place nuts in position above the broken studs and center them. In each case the inside diameter of the nut is slightly larger than the outside diameter of the broken stud.

By means of the electric arc, the studs then are built up to the nuts by several layers of weld metal. Then the nuts are welded to the studs.

Where a number of studs have been broken, Morton and Kramer advise welding them all before removing any. This permits the heat from the arc to accumulate in the casting, expanding it and in most cases making removal of the studs as easy as the removal of an ordinary nut from a bolt by a wrench.

RUBBER SAVING

By Common-Sense Practice in Industrial Plants

BY following a few simple rules during the war-time emergency, every industrial plant in America can extend the life of its equipment made of rubber, thereby adding to the nation's supply of this vital product, according to a statement issued by W. H. Cobb, of the United States Rubber Company. Every time a plant saves 13¼ ounces of rubber, for example, another gas mask is made possible.

"Certain general rules can be applied to all goods made of rubber," according to Mr. Cobb. "Among the greatest enemies of natural rubber are oil, grease, and gasoline. These are all very destructive, and rubber products should be kept away from them as completely as possible. The life of a conveyor belt, for example, is often cut short by destructive operations such as unnecessary abrasion, misalignment, uncushioned impact, as well as being subjected to leaking oil conditions.

"Also, rubber goods should be stored in a cool, dry atmosphere and kept from sunlight and high temperatures.

"Never place rubber in enclosed generator rooms or near electric motors. If the air around these contains even a minute quantity of ozone, which is created by these machines, it will have an extremely oxidizing effect on hose, belting, packing, and other mechanical rubber products, aging them to an abnormal degree."

DISPLAY

Of Samples Enhanced by Clear Plastic

TO GIVE greater interest and identity to otherwise uninteresting and easily lost samples, a technique of molding a block of transparent Crystalite around the samples has been developed by the Adolph Beuhler Company. The plastic, which is stated to be 4 percent more transparent than plate glass, protects the products from corrosion or scratching and permits permanent labelling. The plastic is also less than half as heavy as glass and practically unbreakable, which enables it to withstand rough usage on desks and in desk drawers. Only products which will withstand molding pressures and temperatures can be thus imbedded.

Not Mr. Moto — samples in plastic

INDUSTRIAL TRENDS

WAR, WORDS, PAPER

If records of the paper industry were taken as the only criterion, it would appear that this war, as was almost every war of history, is being fought with paper rather than with hardware. During times of duress, the paper mills hum 24 hours a day, seven days a week, turning out the material on which words are written, with which goods are wrapped. And their associated plants, the pulp mills, work just as steadily to produce a raw material—sulfite pulp—which can be made into paper, or which may become an important ingredient of the explosives that keep wars going.

But we are more concerned at the moment with the product on which words are printed. For several months, now, there have been uncounted rumors about the condition of the paper industry in general, ranging all the way from complete famine to an equally disastrous surplus. So let's look into the mechanism of the industry and analyze its present status as it casts a shadow of future operations.

Perhaps the best starting point of OPM. From this now dead unit came the estimated demand for paper, during 1942, of 26 million tons of all grades. Present estimates of the paper industry's ability to produce shows a figure of about 21 million tons. Is this bad? Not too much so, particularly from the standpoint of the paper manufacturers. Past performances indicate that, when pushed by necessity, they are able to pull figurative rabbits out of the hat—rabbits that will, with the co-operation of paper consumers, tide things over until more normal times arrive.

There is little need to go deeply into the reasons why wartime brings greater demand for paper and paper products. Pulp, mentioned above, is one of them; increased paper work in government circles, is another; demands on the part of the public for news is still a third. But, again, consideration of this phase of the situation is of little moment here: What is of more immediate interest is why the paper industry is being pushed and what they are doing to meet the demands of wartime.

To gain a more comprehensive picture of the industry, it is needful to survey some of the background. Basis of paper is wood-pulp, except in that relatively small part of the production that uses all or part rag content. Until early 1940, a relatively large part of the pulp used in this country was imported from abroad. Canadian and United States forests furnished the rest. When foreign sources were cut off, there was a fair inventory of pulp available in this country, sufficient to keep up paper production until other pulp sources in the United States and Canada could swing into production.

An over-simplified view of the paper industry shows two main factors: Pulp mills, where the basic wood is converted into a form ready for processing, and the paper mills, where the base pulp is made into various grades of paper. Some companies maintain both mills, integrating the two processes into one "production line" unit. In other cases the pulp is produced by one company and sold to the paper maker. In any event, whether the paper producer controls an integrated unit or is dependent upon an outside pulp supply, the effect of war on his business is very nearly the same.

Technological developments during the score of years since 1921 have placed the paper industry in a somewhat better position to meet increased demands than was the case in prior years. Forests of the southern pine regions and of parts of the Pacific Coast, formerly considered worthless for paper making, have become available as sources of pulp. This has been made possible by refinements in processing the raw material so that the resulting pulp will have the requisite characteristics of color and felting that are necessary to produce paper of standard shades and strengths. With these sources of pulp, and with the increasing attention which is being given to controlled cutting of pulpwood and reforestation of cut-over areas, the paper industry as a whole is in a position to meet a large part of the increased demand for its products. And, along with many other industries, producers of paper are gaining valuable lessons through the present emergency. Because of the better business generated by wartime demands, and the consequent increased profits, and because of the technical progress just mentioned, the paper industry as a whole should be in a position to meet most of the requirements thrust upon it during the days of stress yet to come, and to emerge into post-war days with a minimum of dislocation of either pulp production or the manufacture of the finished product.

(A brief comment on the present paper situation, and upon the co-operation which will be necessary between paper manufacturers and consumers, in order that temporary shortages of paper may be dealt with as they arise, will be found on the editorial page, "Our Point of View."

AFTER THE WAR

With all the attention that is being given to war-time production of military and naval needs, it would be short-sighted indeed if industry in general were not giving at least some thought to the course that will be pursued after war clouds pass away and our whole economy must be readjusted to peace-time operations. And regardless of the insistent and necessary cry for all-out production of material of war, conclusion-jumping must not lead to the inference that this thinking-for-the-future is, in one iota, affecting the speed and efficiency with which that all-out production demand is being met. Rather, the two courses, divergent as their ends may be, are supplementing each other, the vision of brighter days to come serving to implement the urge for speed in producing the needs of the moment.

Actually, the two problems involved are identical in almost every respect, and research is the keystone upon which each depends. We must have new, faster, better methods of producing, let us say, tanks. Research in metallurgy and welding shows the way to fabricate these monsters of war without the use of rivets. Result: A better tank, produced more rapidly, and safer for the crew that operates it because there no longer are rivets in the structure that can become lethal missiles when struck on the exterior by projectiles. It is not conceivable that this development is being thought of only in terms of tanks: Other structures, for civilian purposes, will feel the impact of this work in post-war days, if not before.

In every industry a similar process is evolving, sometimes subconsciously, sometimes consciously. Regardless of the mental workings involved, American industry always has had a pretty good memory. When it finds a new way of doing something, it is not long before that way is being adapted, in one form or another, to a variety of uses. Lessons once learned, no matter what the impetus for learning, are rapidly assimilated to the benefit of many.

—*The Editors*

Our Search for the Supernatural

Medium Fails to Appear for Clock-Stopping Test; Dunninger Shows How it Could Have Been Done

A. D. RATHBONE, IV

Secretary, Scientific American Committee for the Investigation of Psychic Phenomena

As STATED in these columns last month, it appears at the moment that most exponents of alleged psychic powers do not desire to try to establish basic, truthful, scientific data concerning their so-called phenomena. The belief that this attitude exists is borne out, we regret to say, by the consistent refusal of Signor Raduano to re-appear before our Committee for further study and test demonstrations of his clock-stopping and table-tilting exploits, performed on the evening of July 21st, 1941, in the presence of our investigating body, guests, and representatives of the press. (September 1941).

As we have repeatedly stated, "demonstrators of psychic phenomena will be permitted to name and to work under their own conditions during the first seance or demonstration." This agreement was followed to the letter in the case of Signor Raduano, who was given absolute freedom to perform whatever feats he deemed pertinent, and he was in no way put to any form of test. However, it is also part of the agreement between our Committee and persons who appear to demonstrate alleged psychic powers that the Committee "reserves all rights to request repetition or duplication of the demonstration or seance under its own conditions, at such time and such place as it may designate, and will undertake to the best of its ability to see that its conditions do not hinder or inconvenience the medium or demonstrator. Failure of the demonstrator to comply with the Committee's request to reproduce or to attempt to reproduce phenomena under the Committee's conditions will nullify any claim the demonstrator may file for the award." (April 1941—Regulation Number 4).

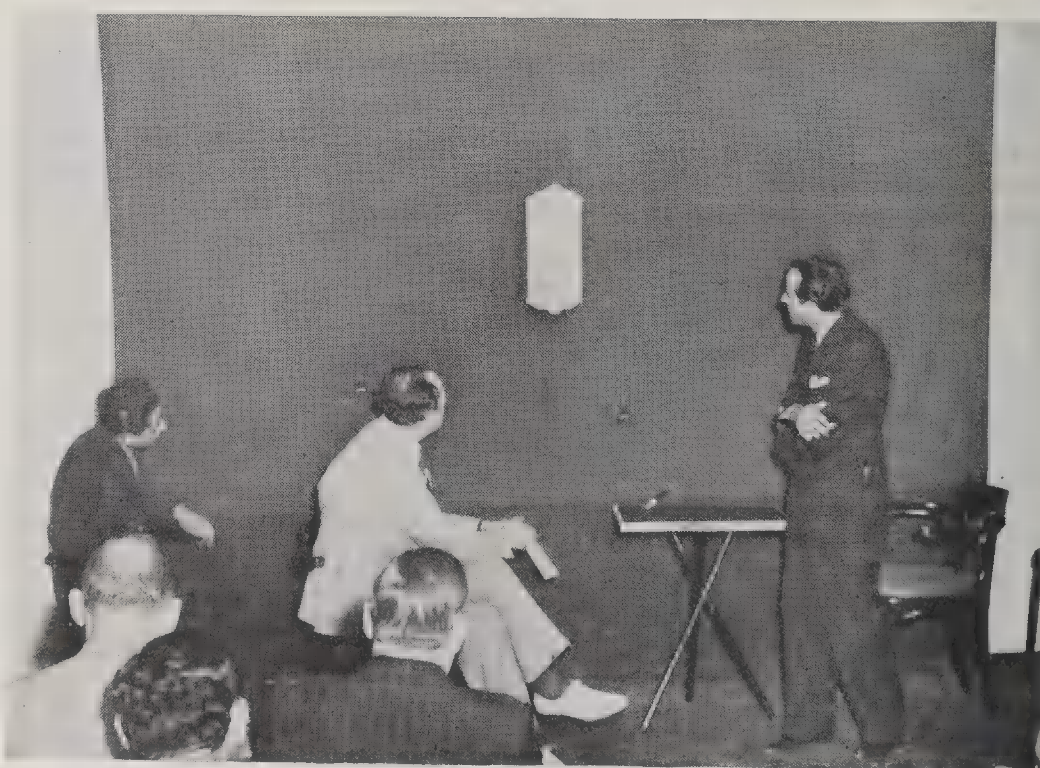
Originally, Signor Raduano agreed to re-appear before the Committee. After his initial and only demonstration, Chairman Dunninger discussed arrangements with the signor and suggested a choice of two forms of simple tests, to both of which Raduano agreed. Notwithstanding his acceptance of both sets of conditions, however, he has consistently delayed his re-appearance, offering various excuses and, more recently, telegrams and special delivery letters have failed to elicit any response whatever.

As stated, the suggested test conditions were elementary. Dunninger proposed: (1) that the identical clock be suspended in a glass case, in full view of witnesses, but completely enclosed so that no mechanical contrivances could possibly be utilized; (2) that the meeting room be divided by a mesh cloth, through which witnesses could discern the clock suspended from the ceiling in the other half of the room. In both plans it was proposed that no one should touch the clock once it had been placed in position for the test, and to these proposals Signor Raduano acquiesced—yet more than six months have elapsed and the agreement has not been carried out.

As the Committee could not render an official report in the absence of test conditions, we have, in deference to the interest shown in our investigation by our readers, requested Chairman Dunninger to draw upon his broad experience as an investigator of the psychic for a possible and plausible explanation of how this particular clock *could* be stopped solely by mechanical means, under the conditions prevailing at the Raduano demonstration. In presenting this explanation, however, it must be remembered that neither Dunninger nor the Committee claims this method was employed by Signor Raduano on the night of July 21st, 1941. Despite this understanding, and unless and until the signor submits to one of the two proposed tests—according to his agreement—Dunninger's explanatory demonstration will be accepted as conclusive and final in this case.

As shown in one of our illustrations, three persons were closer to the clock during the experiments last July than anyone else in the room. Signor Raduano's assistant sat at the left of the clock with his chair not more than a foot or two from the black curtain which had been hung prior to the demonstration at the instigation of the signor. Dunninger sat a little to the left of the timepiece and fully six feet from the curtain. Raduano stood at the right, somewhat closer than Dunninger, but not near enough to touch the clock. The positions of these men are important in expounding this particular theory of modus operandi—particularly that of the assistant, when it is known that the hinges of the clock are on the right-hand side, and that the door, therefore, opens on the side toward the assistant.

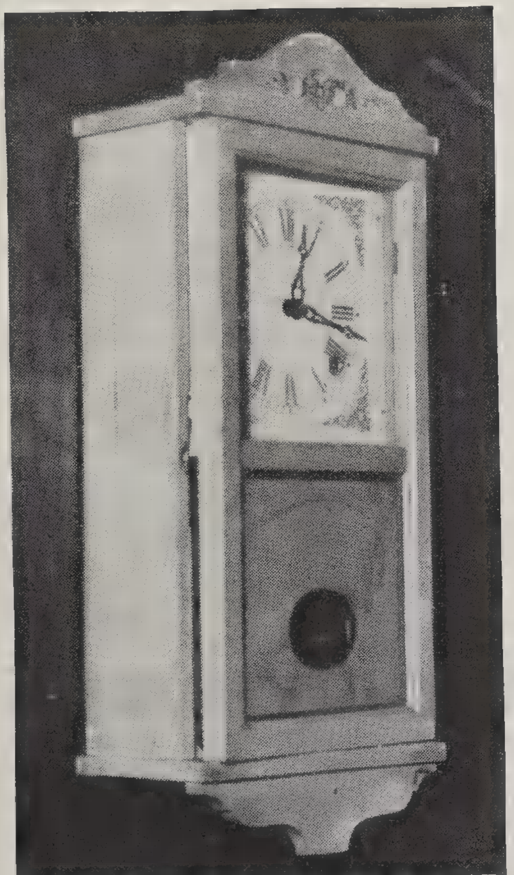
Another pre-eminent factor is that although the clock in its entirety—and also the pendulum weight separately—were each carefully examined by mem-



At Raduano demonstration. The signor's assistant at extreme left, close to the curtain. Dunninger is seated in the center, Raduano stands at the right

bers of the Committee, the clock was taken from the wall and replaced thereon by Raduano's assistant. The pendulum weight, likewise, was both removed and replaced by this assistant, who was the last person to touch either the timepiece or the pendulum prior to both of the demonstration attempts.

It therefore would have been entirely possible, pointed out Dunninger in the course of his own demonstration, for the assistant to have quickly and secretly affixed one end of a black thread to the pendulum weight as he replaced it on its hook. A bit of beeswax, kept plastic by the warmth of the hand, or a tiny piece of ordinary chewing gum, would serve as an adhesive between thread and pendulum. To retain the other end of the thread, allowing slack for the motion of the pendulum, and to leave the clock door open but a fraction of an inch, would be the next move in a routine of this sort. Inasmuch as the door opened on the side where the assistant sat, and inasmuch as the opening would be extremely minute and not



Clock, with door slightly open

visible to persons sitting directly in front in the audience, it would be a simple matter for him to manipulate the thread, wholly camouflaged by the black curtain background, in order to stop the clock.

It will be recalled that Raduano's first attempt was a failure, which may be accounted for by Dunninger's theory that the adhesive failed to stick, or that perhaps it inadvertently fell from the fingers of the assistant, who could hardly have reached down to pick it up without calling unwanted attention to his strategic position. Anticipating a possible objection to this theory, that if the clock was stopped by this means, the pull on the thread might unfix the bit of adhesive, which would be seen or heard as it fell from the pendulum weight, let it be remembered that (1) the adhesive could not fall *out* of the clock as the door was closed too tightly, although not completely shut, and, (2) the amount of adhesive necessary would be so minute that a drop of an inch or so from the pendulum weight to the bottom of the clock case would scarcely cause an audible sound to people seated a dozen feet away.

FROM his position at the left of the clock and close to the black curtain, it probably was next to impossible for the assistant to tell exactly where the hands of the clock were. If he were commissioned by Raduano to exert a pull on the thread at exactly $4\frac{1}{2}$ minutes to nine (the time chosen by newspaper men present at the demonstration for the first trial), his visual perspective of the clock hands would be greatly to his disadvantage. How, then, would it be possible for him to know precisely when to exert pressure? We quote from our report of the demonstration (September 1941): ". . . the signor turned his back to the audience, stretched out his left hand, fingers open, toward the obstinate, still moving clock." This action took place in the first attempt just as the hands pointed to $4\frac{1}{2}$ minutes to nine, and it was the first time Raduano, had either turned his back to the audience or extended his arms, both of which had been tensely folded across his chest up to that moment.

In the second attempt, the signor stood in the same arm-folded attitude until—"At exactly 23 minutes past nine (the time chosen was 9:24) Signor Raduano's right hand shot forward in a determined gesture toward the face of the clock. . . . His fore-finger pointed; then the second finger joined the first." Within 30 seconds after this gesture the pendulum wavered, slowed down, and finally stopped. Therefore, states Dunninger, might not the arm gesture serve as the signal to the assistant that it is time to pull on the thread?

In his own explanatory demonstration Dunninger used a bit of chewing gum as adhesive. He displayed the pendulum weight to witnesses, and as he replaced it in the clock, which was hung on the wall, he affixed one end of a special type of thread, known as "magician's thread," and used by prestidigitators in producing their illusions, to the weight with the speck of gum. He then started the clock, closed the door save for an almost imperceptible crack

Dunninger displays the pendulum weight and the magician's thread

—visible only from the side—and handed the other end of the thread to this correspondent who had been seated in relatively the same position as Raduano's assistant. The thread, even at close quarters against the wainscotted wall and without benefit of the black curtain, was extremely difficult to see, let alone to follow its course to the slightly open door of the clock. Wrapping the thread around his left little finger, this correspondent laid his left hand on his knee, the same relative position as the assistant's left hand, as shown in our illustration. At a signal from Dunninger, the hand was moved slowly and casually toward the hip, tightening the thread. There was a brief feeling of tension to an almost imperceptible degree; the pendulum slowed down, and the clock stopped.

In conclusion of this month's story, we wish to stress heartily the following statements: The explanation herewith presented is not an official report of our Committee, but rather an explanation requested from our Chairman, Dunninger, of simple mechanical means by which a clock of this type, set up under the conditions described, might be stopped. Neither Chairman Dunninger nor the Committee claims that Raduano used this method, although assuredly it is a feasible one, but until such time as the signor is willing to appear again before the Committee, and in the face of his failure to do so under the above described test conditions—which would certainly preclude use of a thread—we are obliged to accept this theory. However, should Signor Raduano desire to re-appear before the Committee, he will be most welcome.

(The subject of table-tilting as demonstrated by Signor Raduano and as practiced by others, will be dealt with in a future issue.—Editor).

Orbit Sleuthing

How the Astronomer Determines the Size and Shape of a Double Star's Orbit

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

FROM the first days of the telescope, astronomers must have noticed that many stars were double. Pairs, some equal and others unequal in brightness, too close to be separated by the naked eye, were clearly resolved by telescopic aid. Rather strangely, no serious attention appears to have been paid to these objects for a century and a half. Finally, about 1780, Herschel began to make measures of double stars—recording the apparent distance and direction of the fainter component from the brighter. His observations were made with the hope of determining the distances of the stars—then wholly unknown. When a bright star showed a faint companion near it, it was assumed that the faint one was much farther away and appeared close to the other only by the accident of its position behind it. If this were the case, the motion of the Earth around the Sun would cause the nearer star to appear to shift back and forth every year, compared to the farther one, just as the frames of a window seem to shift across the landscape beyond as one moves one's head from side to side.

His measures failed to show any perceptible shift of this sort (parallax); but, as years went on, they revealed something far more interesting. In a number of cases the companion star moved steadily around its brighter primary in a curved path. It was not far behind the primary, but was a satellite belonging to it, moving about it in an orbit under the influence of its attraction. The domain of gravitation extended not to the solar system alone, but to the stars. Herschel had made a greater discovery than he had hoped for. He compared himself to "Saul, who went out to seek his father's asses and found a kingdom."

Systematic and intensive study of double stars began with Wilhelm Struve in 1830, and has led to the discovery of more than 20,000 pairs. Knowing the number of stars of a given magnitude in the whole sky, found by actual counting, it is easy to calculate in how many cases two stars of, say, the 6th and 8th magnitudes should be within, say, 10″ of one another, provided they were sprinkled quite at random over the heavens. It is thus found that only a small fraction of the observed number of double stars can be "optical" pairs, due to chance, with one star really far behind the other. The great majority must be "physical" pairs, not much farther apart in space than they look. In a great many cases the physical connection is proved by the fact that the two stars are moving together across the sky with a common proper motion; and there are more than 2500 pairs for which slow orbital motion has been detected. The number for which even tolerably good orbits have been calculated was 166, two years ago (at the time of an extended study by the writer), and is probably about 170 today.

WHY should this difference be so great? The obvious answer is that most double stars move so slowly that they have not had time to go around their orbits, or to complete any considerable fraction of a revolution, in the short interval of 112 years for which there are reliable observations. Unless our observations cover a considerable fraction of the whole circumference of the orbit, we can get no reliable results. This may seem strange, when, in the case of a planet, such as Pluto, a good determination of the orbit can be made from observations extending over only a few percent of the period.

The main reason for the difference is that the observations of a planet are of an enormously higher percentage of accuracy. It is easy to observe the position of an asteroid in the heavens to a second of arc, that is, to less than a millionth part of the circumference of the celestial sphere. By the time it has advanced one tenth of the way around its orbit, the observations determine the angle through which it has moved to better than one part in 100,000. With data of this precision, refined analytical methods may be employed, which, despite the complications arising from the fact that we observe the planet from the moving Earth, lead us to our goal. But the percentage of precision of the observations of a double star is low. Most of the rapidly moving pairs can be separated only with powerful telescopes, and never appear as much as 1″ apart. An accuracy of about 5 percent in the measures of distance, and a corresponding uncertainty in the "angle of position," is all that can be expected from even good observations.

Now the real orbit is an ellipse, with the bright star at one focus. It is not at all likely to be seen squarely, "in plan"; its plane is almost always tilted at an angle to our line of sight, so that we observe a foreshortened orbit—still elliptical in form, but with the star not at the focus. Occasionally we see the orbit edgewise, and the smaller star appears to oscillate from one side to the other of its primary along a straight line.

TO FIND the size and shape of the real orbit from the foreshortened projection of it which we observe, is a purely mathematical problem, which has been solved in more than a dozen different ways—all correct, but some quicker and more convenient for the calculator than others. To work this through takes but a few hours.

But to draw the apparent ellipse from which the calculations start is much more difficult. If we had observations covering a whole period, and fixing points all round the orbit, even with low accuracy, it would be easy enough to draw an ellipse to represent them; but astronomers, being human, are impatient, and do not like to wait for decades, or perhaps centuries, until this has happened. They naturally want to determine the orbit from as small an arc of the whole ellipse as possible and here the errors of observation become troublesome.

For motion along a straight line, things would not be so bad. Given a number of observations—represented by the dots in *A*, Figure 1—not only the position of the mid-point of the line, but its direction are determined with fair accuracy. But if, as in *B*, we have to represent these points by a circle which passes as close to them as possible, our results are far less accurate. The mid-point of the observed arc, and the direction of the tangent there, can be determined nearly as well as in the case of the line. But the radius of the circle, or, what is equivalent, its

curvature away from the tangent, is badly determined. The observed arc is but a small part of the whole circle, and an arc of a circle of considerably larger or smaller radius can be drawn so that within this small range, it deviates from the first circle by less than the errors of the observations. Even a straight line would give a fairly good-looking, though not a satisfactory, fit.

For an ellipse the case is much worse, for its complete specification depends on five quantities (instead of three for the circle), and it is possible to draw great numbers of ellipses, very different in form and size, which all lie so close to the circular arc that they could hardly be distinguished from it within the small observed region. This is illustrated in *C* (copied from one of the beautiful diagrams in Burnham's "General Catalogue of Double Stars"). The circular apparent orbit, which gives a period of 300 years, and the ellipse with a period of 130 years, represent the observations from 1830 to 1900 equally well. Later observations show that the companion has been moving a little outside the smaller ellipse, and that the period is about 150 years. The law of areas holds true in the apparent orbit; hence the period corresponding to any ellipse can be found by comparing its total area with the area swept out by the line joining the stars in a known time.

With ordinarily good observations, such as are shown in *C*, it is rarely possible to fill in the remaining portion of the apparent ellipse with any assurance until the observations cover about half its circumference. With more accurate observations, a shorter arc should suffice.

The most precise method of measuring the relative positions of the stars is by photography; but photographing double stars is peculiarly difficult. To begin with, the image of a star on even the best plates is very much larger than the optical diffraction image in the focal plane. This happens partly because the photographic action spreads on the plate, partly because, even with the steadiest air, the star-images dance about a little. The visual observer can take advantage of the best moments when the images are sharp; on the plate, the good and bad moments combine to produce a smeared-out image. Close doubles therefore are the exclusive province of the visual observer. Somewhat wider ones show on photographs as elongated images, unsuited for measurement. Even when the two stars are just separated upon the plate, there is trouble. The photographic effects on the inner edge of the two images may overlap, bringing them too close together. On the other hand, the developer may be partially exhausted in this region of the plate, and act more strongly on the outer edges of the images—which makes their apparent centers too far apart.

Practical experience has shown that these effects spoil the accuracy of the photographs, unless the images are approximately $\frac{1}{6}$ of a millimeter apart. With a focal length of 10 meters—a big telescope—this corresponds to $3''.5$. Pairs as wide as this have usually been observed with small telescopes, as observers who have larger ones naturally work on the close pairs which the small instruments cannot separate; but this is no longer the case.

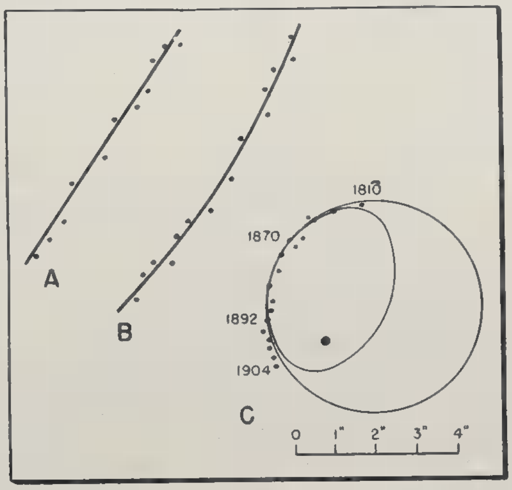


***Figure 1:* Working principles**

The first serious photographic measures of double stars were made in 1914 by Hertzsprung and showed at once that a previously unprecedented accuracy was within reach. Fifty or a hundred exposures can be taken on a single plate, so that the random errors are greatly reduced in the mean. Difficulties due to atmospheric dispersion—which raises the apparent altitude of blue stars more than red ones—can be eliminated, and the sharpness of the images improved, by photographing through a yellow screen, which transmits only a narrow range of the spectrum. If the components are of unequal brightness, the images of one will be under-exposed, or of the other over-exposed, with serious loss of accuracy. This is avoided by placing in front of the objective a coarse grating, consisting of narrow metal bars, equally spaced. Observed through this each star image is flanked by fainter ones on each side (actually very short spectra) whose mid-point coincides exactly with that of the over-exposed central image. The difference of brightness between these and the central image depends on the ratio of the width of the bars to that of the spaces between them. With three or four suitably designed gratings, it is always possible to pick one such that the brightness of the lateral images of the bright star is nearly equal to that of the companion. Accurate measures can then be made with only a little extra work.

Hertzsprung's work has been continued, first in Holland and then in this country, by his pupil, Dr. K. Strand, who has specialized upon bright, slow moving, binary stars. For such pairs, the photographs give positions whose errors are hardly more than a tenth of those of the old visual measures.

Observations of this sort, continued over a decade or two, fix the position of the corresponding portion of the orbit so accurately that there is far less latitude left in drawing the ellipse, even though the observations cover but a small part of it.

Dr. Strand has in this way determined reliable orbits of a number of well-known, but slowly-moving pairs, for example Eta Cassiopeiae (period 526 years) and Castor (period 380 years). He has just reported success in what has previously been regarded as a hopeless case—61 Cygni.

This is the first star whose distance was measured—by Bessel in 1838—and still ranks as one of our nearest neighbors. The relative motion of the pair has been carefully followed for the past 110 years, but shows so slight a curvature that no one has been bold enough to extend the observed arc into the whole ellipse.

Modern photographic observations from 1914 to 1941 have been supplemented by measures on photographs taken by Rutherfurd in New York between 1871 and 1874.

Utilizing these, and a great mass of visual measures, Dr. Strand finds a period of 720 years, and a mean separation, after allowance for foreshortening, of $24''.64$—the largest yet found for any double star orbit. The real separation corresponding to this is 84 astronomical units, and the combined mass of the two stars 1.16 times the Sun's—which is what might be expected, as they are red dwarfs, much fainter than the Sun.

The system is approaching the Sun at 63 kilometers per second, and after 720 years its distance will have diminished by one part in 75. Hence, when the astronomers of the future observe it in the same part of its orbit, the companion will not appear to follow exactly the same track, but one $0''.3$ farther from the center. Followed through further centuries, it will appear to move in a slowly expanding spiral, till, at long last, the star reaches the point on its track nearest the Sun.

Fidgety Atoms Purify Water

Ozone Treatment of Community Supplies Has Proved Efficient in Practical Applications

R. G. SKERRETT

OZONE, today, has attained both industrial and technical significance, thanks to the joint labors of electrical and mechanical engineers. As a result of these collaborative efforts ozone, among other applications, is now making it possible to transform unpalatable water into a hygienically suitable liquid that is completely acceptable to discriminating tastes—a matter of vital interest to a steadily increasing percentage of the nation's population. As the sizes of communities grow and existing water supplies diminish relatively, the problem of pure water and plenty of it is becoming more pressing year by year. To offset deficiency, water must be sought from sources that may be polluted—and the responsible sanitary engineers have to resort to treatments, chemical and otherwise, to remove the impurities. Because of the percentages of chemicals used, such water, when delivered to the householder, for example, may have a decidedly unpleasant taste. Here it is that ozone now comes into the picture.

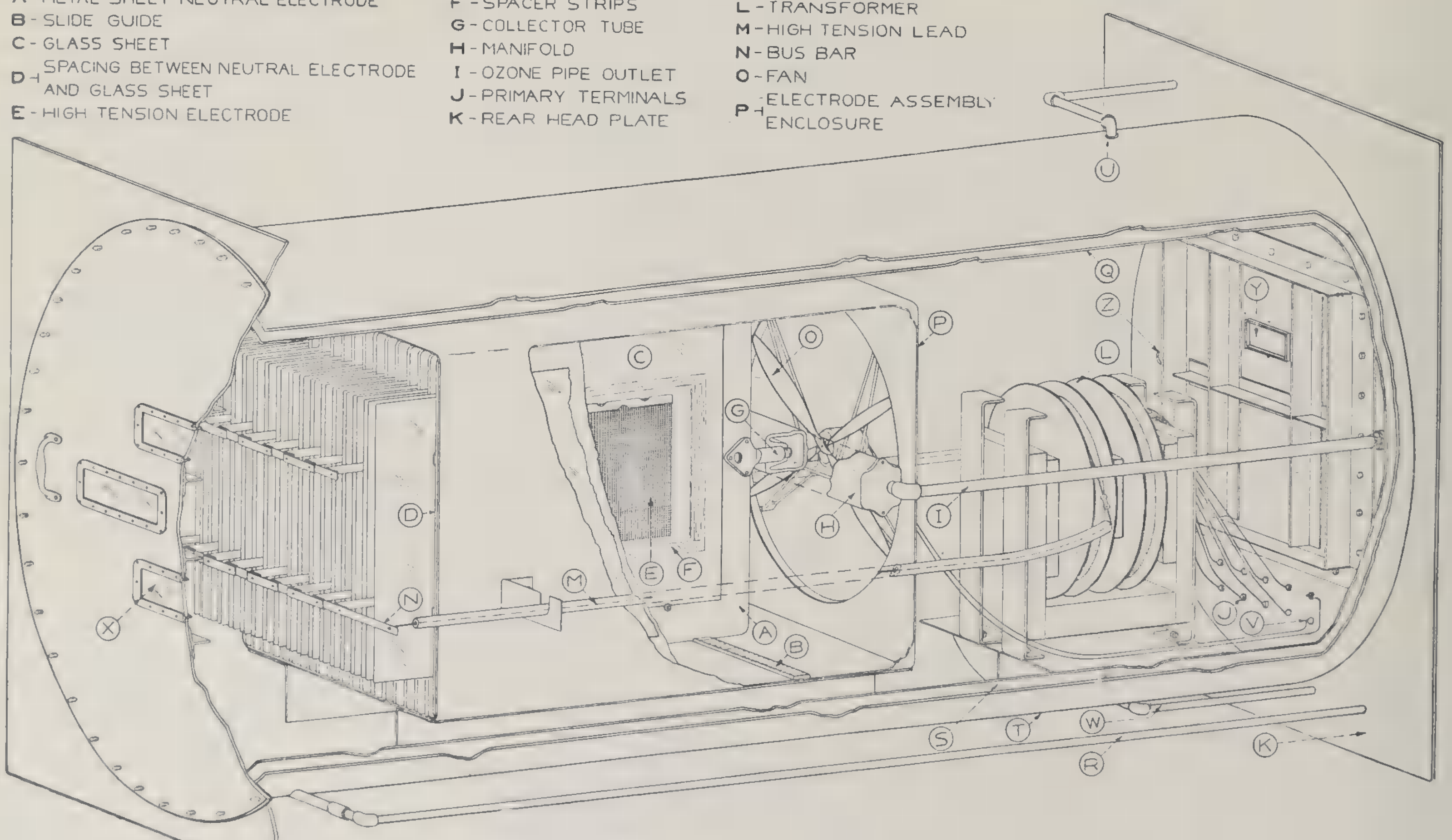
Perhaps what ozone can do can best be understood by describing how it has helped in two cases. Denver, Pennsylvania, a community of 2100 people, for many years relied upon spring water to meet its needs. Then, increased consumption necessitated the damming of a nearby creek and running that occasionally turbid water through a sand-filtering plant having a daily capacity of 300,000 gallons. During a drought in 1939 the lowered water of the creek developed disagreeable odors and tastes that persisted after the water had been filtered and sterilized by chlorination. The citizens of Denver complained loudly: to provide corrective measures, ozonation equipment was installed. The plant has a rated capacity of five pounds of ozone daily; and, small as that may seem in comparison with 300,000 gallons of water per diem, the effectiveness of the ozone was equal to the situation, and the water was found entirely satisfactory to Denver's people.

Whiting, Indiana, put the ozone treatment to a still more difficult test. Whiting is a city of 11,000 people that draws its water supply from Lake Michigan in an artificially created basin flanked by two steel bulkheads jutting out from the shore line and spaced several miles apart. Into that partially enclosed water area is discharged most of the waste of 150 industrial plants.

POLLUTION is further increased by the sanitary sewage of 250,000 people living in the neighboring region, through which flows the Calumet River. Raw water for Whiting enters an intake about 1400 feet offshore, and, prior to 1939, this lake water was filtered and treated chemically to make it safe for use. But when it reached the consumer, it had objectionable odors and an oily, tarry, and phenolic taste. Something had to be done, and the local authorities decided to try ozone.

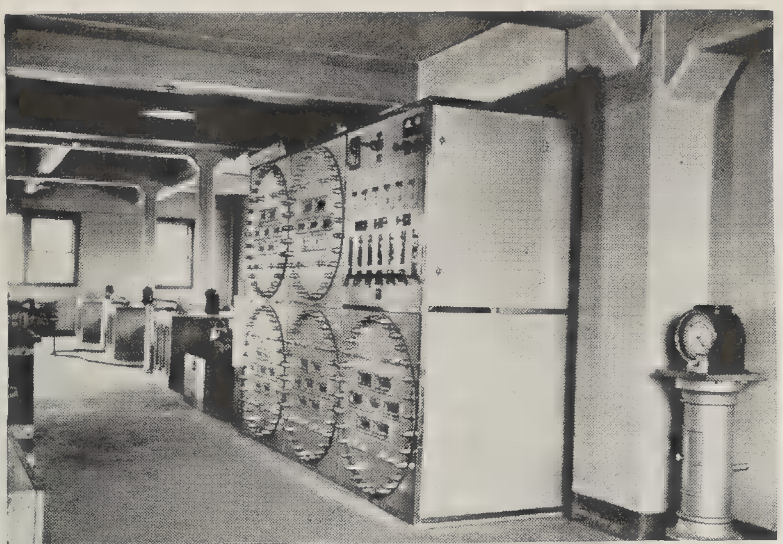
A pilot ozone plant was installed and for more than a year was run success-

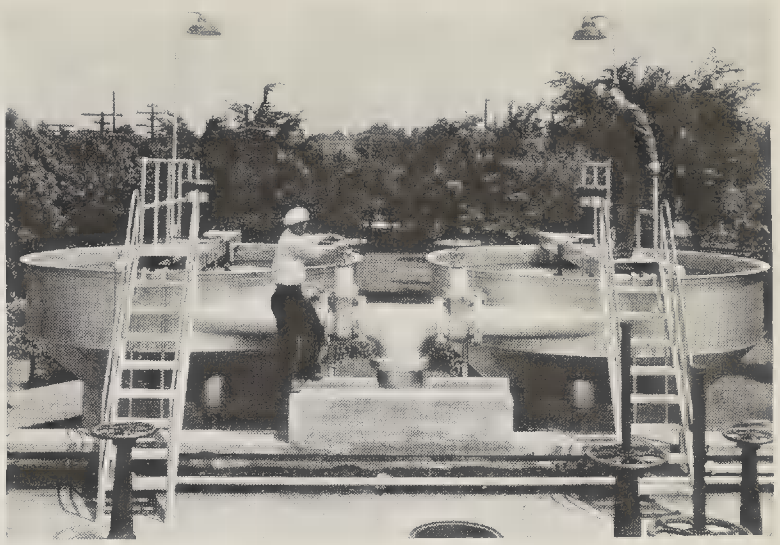
A - METAL SHEET NEUTRAL ELECTRODE
B - SLIDE GUIDE
C - GLASS SHEET
D - SPACING BETWEEN NEUTRAL ELECTRODE AND GLASS SHEET
E - HIGH TENSION ELECTRODE
F - SPACER STRIPS
G - COLLECTOR TUBE
H - MANIFOLD
I - OZONE PIPE OUTLET
J - PRIMARY TERMINALS
K - REAR HEAD PLATE
L - TRANSFORMER
M - HIGH TENSION LEAD
N - BUS BAR
O - FAN
P - ELECTRODE ASSEMBLY ENCLOSURE



Q - INNER CYLINDRICAL SHELL
R - INLET WATER PIPE
S - WATER SPACE
T - OUTER CYLINDRICAL SHELL
U - OUTLET WATER PIPE
V - FAN TERMINALS
W - DRAIN PIPE
X - FRONT WINDOWS
Y - REAR WINDOW
Z - AIR INLET

Cutaway drawing of an ozonator — ozone generator for water purification





Illustrations courtesy Ozone Processes, Inc.

Left: Five ozonators and control panel. Right: Upper sections of two ozonizers

fully under the varying seasonal conditions and consumption demands, which ranged daily from 2,000,000 to 4,000,000 gallons of raw water, first passed through a filtration plant. Before the test was started, the established treatment of the water followed these stages: aeration; preammoniation, just before prechlorination; prechlorination; coagulation with alum; mixing in a baffle tank; sedimentation in two large tanks; rapid sand-filtration in six gravity filters, and then, when needed, final chlorination—this last chlorine treatment imparting to the water its particular added measure of taste and odor. Because of the effectiveness of the ozone pilot plant, the city contracted for ozone-generating equipment consisting of five units, each having a rated capacity of 10 pounds of ozone a day, although actually able to produce 16.5 pounds every 24 hours.

Previously, at Whiting, chlorine was applied at two stages in the purification process in order to combat the normally heavy initial pollutions of the raw water and to assure proper sterilization before turning the water into the city mains. The ozone plant was primarily added to eliminate bad tastes and odors but, in the end, some of the ozone was used as a sterilizer, and so brought about a very substantial reduction in the use of chlorine, alum, and ammonia. The changes effected have been summed up: "The days of consumer complaints and the extensive use of bottled spring water were ended. For now, Whiting, despite the well-nigh impossible conditions governing its supply, had an acceptable and safe drinking water."

Normal oxygen and ozone—which is born of oxygen—differ in their makeup. The oxygen of the free air is represented by the symbol O_2—the numeral indicating that the molecule of oxygen is a union of two atoms of oxygen—while the symbol of ozone, O_3, indicates that a molecule of ozone is made up of three atoms. This third atom in ozone is not strongly attached to the two other atoms, and, with suitable provocation, will break away from the combination and hungrily attack any nearby oxidizable substance. The main difference between oxygen and ozone in oxidization is that ozone is far and away the more active agency. Due to this vigorous oxidizing action, ozone is a powerful germicide, peculiarly valuable in rendering tainted water fit for human consumption. This is not a new discovery: Europe has led us for the better part of half a century in this use of ozone, but its application to water purification on a large scale is decidedly recent in this country.

Ordinarily, in purifying water by any of the commonly employed methods, oxidation is one of the stages of treatment; sterilization and precipitation of suspended organic matter are brought about by the use of chlorine to deal with bacteria, and the employment of alum to induce precipitation. Chlorine, because of the quantity necessarily used, leaves an after-taste that is objectionable to the domestic user. However, ozone is able to destroy disease-causing bacteria as well as to rid water of offensive odor and unpalatable taste. That fidgety third atom, which characterizes a molecule of ozone when it breaks away from its two associate atoms and becomes a "free agent," does its good work rapidly in attacking oxidizable matter and then disappears without leaving any trace of itself behind.

Ozone is today generated by the most improved process in an ozonator to which compressed air is delivered in a prescribed condition of cleanliness and dryness. The air is passed through a silent blue corona discharge which is induced between electrodes on the opposite sides of a dielectric plate operating at from 8000 to 16,000 volts. Just what happens to the air so exposed to the discharge is not fully understood, but that need not concern us at this time. An accompanying diagram reveals the essential features of an up-to-date ozonator: the air that issues from it carries about 0.5 percent ozone. Still under some of its initial pressure, the ozonized air is then piped to an ozonizer to meet the filtered water that is to be treated.

The ozonizer, shown in one of the photographs, and not to be confused with the ozonator in the diagram, is an upright cylindrical tank into which water enters at the top, and in dropping meets the rising ozonized air which is discharged from nozzles near the bottom of the cylinder. Power-driven paddles, placed midway in the contrary courses of the water and the ozonized air, induce thorough mixing of the fluid and the gas, and the treated water is drawn off from the bottom of the tank. That water, according to given conditions, may undergo further treatment before being turned into the distributing system of the local community, or it may be led directly into the mains.

At the present time, the city of Philadelphia is operating a pilot test plant at its Lower Roxborough filter station to ascertain how far ozone may be depended upon to "sweeten" raw water drawn from the Schuylkill River which, because of industrial wastes, has an objectionable chlorophenol taste when distributed to users. Actual performance figures cannot be disclosed at this time, but ozone will probably be found the means of bringing about the desired betterment, for the conditions at Philadelphia appear to be easier to master than those that prevailed at Whiting before ozone was tried and proved to be a satisfactory hygienic agent in that city.

Excavating for Meteorites

One Large and Two Small Craters Made by Violent Impact are Under Geologic Exploration in Texas

EXCAVATIONS at the site of three meteorite craters, a large one and two small ones, nine miles southwest of Odessa, Texas, recently have attracted geologists and tourists to the sand-hill dotted prairies in the western part of the state.

Discovery of two new craters adjacent to the giant pit, which has been under exploration for two years by field crews from the University of Texas with the assistance of the Work Projects Administration, has heightened interest in the study of the phenomenon.

All three meteorites are believed to have crashed to the earth about 40,000 years ago, their terrific speed resulting in a concussion far more than comparable with that caused by the bombs of modern warfare.

The main crater, second largest in the United States, has been studied and explored since 1939. It is about 500 feet in diameter at the level of the earth's surface and 50 feet deep. The meteorite itself, according to Dr. E. H. Sellards, director of the University of Texas's Bureau of Economic Geology, who is in charge of the project, has been determined to be about 164 feet below the bottom of the crater.

One of the newly discovered craters is 70 feet in diameter and about 17 feet deep, and contains as many as "six to seven thousand meteorites with a total weight of about six tons," Dr. Sellards estimates. He believes that the crater was caused by the smashing into the earth of a closely packed swarm of small meteorites, rather than by a single mass breaking into thousands of pieces as it struck.

The other pit is similar in formation but smaller. The two new craters were discovered last Autumn, hence there has been no time to make an exhaustive study.

Under the direction of Dr. Sellards and Glen Evans, assistant, 35 exploratory drill holes have been put down in and near the main crater. Observations have also been made from additional trenches cut at the sides, and from core drilling.

An elevator shaft is being sunk in the center of the crater. When it is completed, visitors will have an opportunity actually to see the meteorite fragments. Present plans are to maintain the site as an educational exhibit open to the public, when excavations are completed.

From their observations of the main crater, Dr. Sellards and Mr. Evans have determined that rock from as deep as 70 feet below the surface was thrown out by the impact of the meteorites. Also, that all rock strata in and immediately around the crater were moved from their original position, and that rock strata forming the crater walls were lifted, broken, folded, and faulted. "On the surface, the rock debris is chiefly blocks of limestone, often covered and cemented together by caliche," they state in their report on the progress of the investigation. "Pits and trenches cut outward from the rim show that large blocks of shales are included with the limestones. Search among the rock debris enables one to recognize rocks coming from various parts of the geologic section of this locality down to a depth of about 70 feet. The largest of the limestone blocks are three or four feet across. Some of the shale masses are of equal size and larger. Many of the limestone boulders have disintegrated, and the shale persists only when protected by overlying debris. At some places a secondary accumulation of caliche cements the ejected rock, indicating considerable length of time since the crater was formed and the rock thrown out. The maximum thickness of the debris around the rim is now 10 or 12 feet. It was doubtless thicker when the crater was first formed.

"At the present time the crater is filled within five or six feet of the level of the surrounding plain. The latest fill consists of fine, red, incoherent silt with some fine sand. The stratum is lens-shaped, having a thickness of 25 to 30 feet at the center and thinning out to the margins. Some of the sediments are of a degree of fineness such as to indicate that they probably settled from the atmosphere slowly, while the others are coarser and were probably wind-blown. This stratum of silt and wind-blown sand, with few pebbles and little or no caliche, readily separated throughout the entire crater from the older, more consolidated and more or less calichified underlying sediments.

"NEXT underlying the silt is a stratum, lighter in color, which consists in part of silt with which is included pebbles and pieces of rock washed in from the rim of the crater. Caliche has formed in this stratum, resulting in partial cementation. In the central part of the crater this material is 45 to 50 feet thick. The definite line of separation between this and the overlying stratum, together with the difference in texture and origin, suggest that an appreciable time interval separates them.

"Some of the rock thrown out by the meteor fell back into the crater. In the

Sectioning excavation of the small crater near the main one

central part of the crater this stratum of fragmental rock at the bottom of the crater is 10 or 15 feet thick and is readily distinguishable from finer materials above and below."

Immediately below the fragmental rock, they say, is a stratum of rock flour. "In this zone the sand grains were completely shattered by the meteor so that, when rubbed, they remain only as a coating on the hand," the report states, "The rock flour is thickest near but somewhat northeast of the center of the crater. From its place of maximum thickness it thins in all directions, forming a lens lying within and not extending to the margins of the crater."

The conclusion reached by Sellards and Evans is that the rock flour is shattered limestone, and that the impact which shattered the sand grains may have originated from the vibration waves.

The land elevation at the crater is near 3050 feet. The greatest depth at which rock flour was found by drilling is at an elevation of 2946.9 feet, or about 103 feet from the plain's surface. The meteorite encountered in drilling lies at an elevation of 2880 feet, or approximately 67 feet below the lowest known rock flour and about 170 feet from the original surface.

Placing plaster around one of the meteorites to remove it safely

A magnetometer survey, verified by drilling, indicates that the principal meteorite masses lie very nearly under the center of the crater.

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WEED KILLER

For Lawns, Does Not Injure Grass

A CHEMICAL weed killer which does not permanently injure grass, yet is claimed to rid lawns of practically all common weeds, is applied in liquid form by spraying it over the surface of the lawn. Exhaustive field tests of this material, known as Lawn Sinox, have been conducted in co-operation with agricultural colleges and experimental stations.

After a lawn has been sprayed according to directions, a temporary browning of the lawn grasses will be noticed. This condition exists for from several days to two weeks but the lawn grasses will fully recover while the weeds will not.

BATTLING BATS

Bright Lights Solve a University's Problem

FOR more than 25 years, bats have been a problem in the buildings now occupied by St. Mary's University, San Antonio, Texas. They infested the attics, or worked themselves into the very narrow space between the metal roof and the sheeting, or attached themselves behind rain-spouts, or even entered below the window sills and behind the window frames. Efforts have been made periodically to get rid of them, with little success. But the problem has finally been solved, quite simply, by making use of bright lights.

Efforts made at St. Mary's to dislodge the bats, without injuring or killing them, yet to keep them away permanently, fall roughly into four classes, according to a recent communication from W. R. Lamm, S.M.

Disturbing the bats during the day and keeping them moving was only partially effective. Soaking the bat lodging places with kerosene or creosote or pressing lime into them was effective for only a short time. Noises of various types—bells, buzzers, whistles, supersonics, radio, and the like were partially effective; the bats left for a while but came back again. Furthermore, the noise was as annoying to human beings as to bats.

The fourth method solved the problem. Bats don't like light. They roost in dark places and leave the roosts at night, returning at dawn. Hence bright lights were placed at the opening where the bats entered and left the building and these lights were turned on in the morning when the bats were returning. Within a few days all the bats were gone and did not return. Should they do so, the lights will simply be turned on again and will be kept burning for about 45 minutes every morning and evening. The method is effective, simple, inexpensive, safe, and not bothersome to the human beings in the buildings.

LO, THE SWOOSE

Or you Might Call it the Gwan

THE SWOOSE, a hybrid between swan and goose, was one of a strange Noah's Ark of cross-bred fowl recently paraded before an audience of geneticists by Dr. Charles W. Knox and Dr. Joseph P. Quinn of the United States Department of Agriculture. Another was a hybrid of guinea-hen and ordinary barnyard fowl, which you may call guin-hen, or guiowl, or guicken, as best suits your fancy, says *Science Service*.

The swoose is a very peculiar-looking bird, Dr. Knox stated, intermediate between goose and swan in size and shape, but with the swan's long neck. Sweese (presumably that's the proper plural) have been produced several times in the past. The first one on record was described by the famous French naturalist Cuvier, in 1808, and there have been a half-dozen scientifically authenticated sweese since that time.

Since they are incapable of normally rapid reproduction, the hybrid birds have no economic future, and are of interest mainly as scientific curiosities. This is a pity, at least as regards the guinea-hen-chicken hybrid, because most specimens are much bigger than either of the parent stocks—sometimes twice the weight of the heaviest parent.

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LEG BANDS: Metal substitutes have even reached the chicken farm. Leg bands, identifying markers used by poultrymen and formerly made of aluminum, are now being fabricated of various plastics or of soft metal composition.

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FUSE-CHANGING

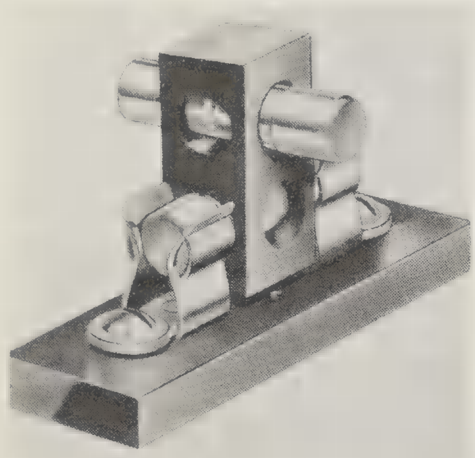
Made Convenient With New Holder

ENTIRELY new convenience for changing fuses in close quarters—replacing a blown fuse in a twinkling and giving notice on inspection that another spare is required—are features embodied in a spare fuse holder and puller combined, just announced by Littelfuse, Incorporated.

The fuse in circuit goes through one end of the soft rubber rectangular holder, between the clips. Above, and

at right angles, is an opening in the holder for the spare fuse. When inserted, the caps of the spare fuse project beyond the holder, affording an easy grip for two fingers.

When the fuse in circuit blows, all the operator has to do is to pull and reverse the Littelfuse holder. This puts the spare fuse in circuit and brings the blown fuse on top in the same position



The spare is right there

that the spare was in before. One end of the holder is painted red. Until a fuse change is necessary, the red end is underneath, out of sight. When a reverse is made, putting the spare fuse in circuit, the red end is brought into full view on top. To an inspector or service man this red signal indicates that a fuse has blown and that another spare is required.

SLIDE RULE

Adds, Subtracts, And Converts Decimals

An aid to making and checking calculations for mechanical drawings, laying out machine-shop jobs, making patterns, and so on, is to be found in a new calculating device, known as the Sum-Up Slide Rule. Unlike the usual slide-rule which multiplies and divides, this new device adds, subtracts, and converts decimals of an inch, fractions, and millimeters interchangeably.

MILEAGE

Determined For Average Stock Car

A new car is a new car, if you can get one, but—breathes there a motorist with curiosity so dead who hasn't wondered how much mileage was left in the old one?

In a four-month road test on a fleet of 1940 stock cars, oil company researchers found the answer—mileage up to 112,000 miles—and still going strong. During the test period in which the cars were driven night and day at an average speed of 50 miles per hour over a 171-mile Florida course, top speed was two miles less than when the cars were new and mileage per gallon of gasoline was better! No carbon was cleaned throughout the test.

At 10,000 miles the fleet made 18.5 miles per gallon on an average; at 75,000 miles 19.1, and at 100,000 miles it was 18.9. Gasoline economy increased as driving speed increased up to about 20 miles per hour, and then fell off. In 10,000 miles of driving the anti-knock requirement increased from 64 to 73 octane and at 50,000 miles it leveled out to about 75 octane. With suitable fuel, lubrication, and servicing the cars maintained throughout at least 100,000 miles what is—for all practical purposes—new-car acceleration time.

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HEAT LOSS—Approximately 50 percent of loss of heat in a home is due to air infiltration through the walls. Plywood panels 5/16 of an inch thick have about twice the insulation value of ½-inch plaster on lath.

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CURIOSITIES

Of the Laboratory Meet Commercial Demands

Two new industrial chemicals—sulfamic acid and ammonium sulfamate—costly laboratory curiosities only three years ago with few known practical uses, are now in tonnage production at du Pont's recently completed Grasselli, New Jersey, plant. Formerly produced on pilot plant scale, sulfamic acid and ammonium sulfamate proved themselves valuable in many industrial processes. An interesting application of the latter chemical has been in its wide adoption as a fire retardant in textiles, insulation products, and paper. While flammable material treated with ammonium sulfamate will char upon contact with flame, it will not blaze. Thus the treated material will not support fire.

Clothing, curtains, and draperies are being "flame-proofed" with ammonium sulfamate by many laundries and dry-cleaning houses, while workers' uniforms in plants where fire-hazard is high are being protected on an increasing scale, the manufacturers point out.

Ammonium sulfamate, though harmless to humans, has proved itself effective in killing weed pests such as poison ivy, ragweed, and thistle, without injuring the soil.

Sulfamic acid is valuable in leather tanning, for nitrite removal in the manufacture of dyes and color lakes, and also as a laboratory reagent.

Chemists explain that sulfamic acid utilized in the bating, pickling, and tanning processes of leather results in a silkier and tighter grain. This white crystalline solid is odorless, highly soluble in water, non-volatile, and non-hygroscopic.

CLEAR WATER

At All Times, In Metal Containers

By adding a small quantity of a harmless chemical to water that must be kept in metal storage tanks, all formation of rust and corrosion is prevented; when the water is withdrawn from such tanks, it comes out just as clear as it goes in.

The chemical used for this purpose is commercially available under the trade name Aqua-Clear. In the case of old and rusty tanks, a few treatments will clean out the old rust and the water will flow clear as long as the film deposited on the tank interior by the chemical is maintained.

Use of this clear, tasteless, harmless liquid is advocated for drinking water tanks in boats, in hot-water heating systems to prevent rust and corrosion in the pipes and radiators, and in automobile cooling systems.

PROJECTED WRITING

For Use by Teachers and Lecturers

A class room lecture desk which allows one to write on cellophane stretched over a plano-convex lens on the desk top and have his writings projected onto a large screen on the front of the desk, may change future methods of visual education.

Invented by David Katz of Wil-

"Scriptoscope"

mington, Delaware, this desk, called the "Scriptoscope," enables a teacher or lecturer to illustrate his discourses without turning his face from the audience. Sitting at his desk, he draws his sketches or diagrams with a wax pencil on rolls of cellophane stretched across a 10-inch lens.

A beam of light from above the desk is directed through the plano-convex lens; a system of lenses and mirrors intercepts this beam and projects it on the screen.

The screen, about 24 by 30 inches, may be built above or below the desk top. It may be used in a well illuminated room or in daylight, provided it is shielded from direct rays of the sun.

The rolls of cellophane give a permanent record of a lecture, and may be used for reviewing without again rewriting all the material. Pre-fabricated diagrams and sketches, especially complex ones, may be drawn before a lecture and slipped under the cellophane; and the lecturer may write what he wants on the cellophane without spoiling the diagram.

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INSECTS—Damage caused by insects may be conservatively reckoned at two billion dollars annually in the United States.

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GEMS

The American Indian Was a Gem Collector

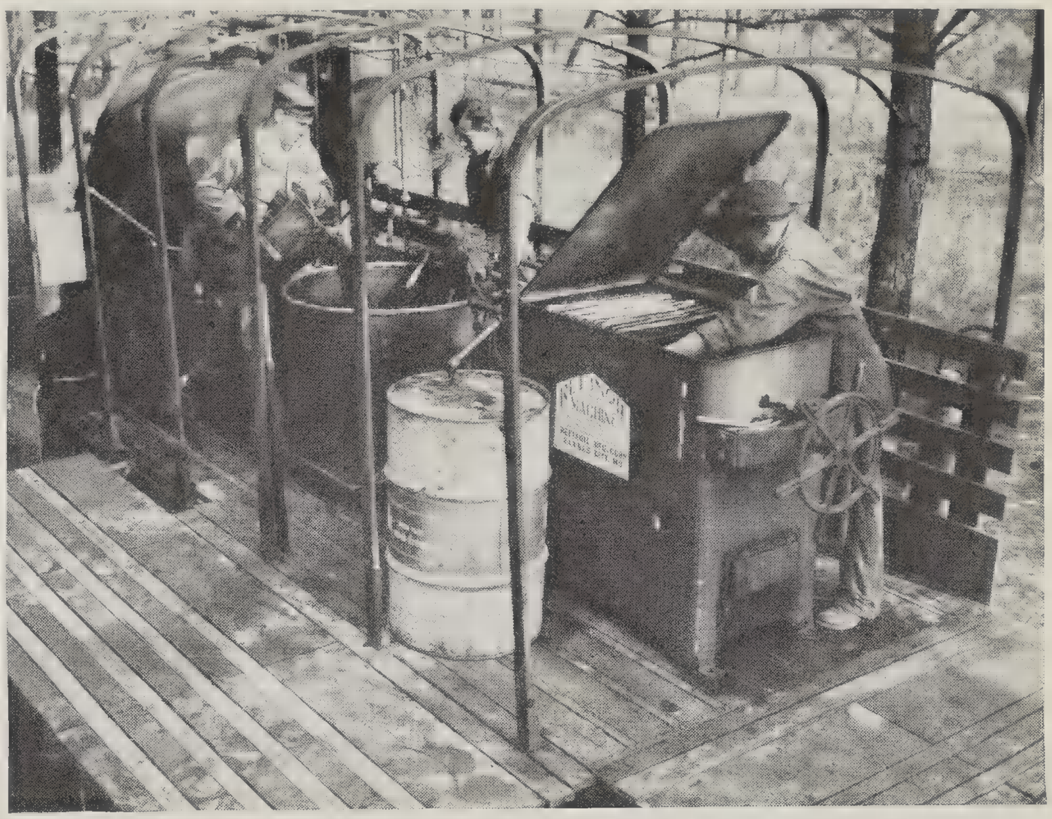
Some of the fanciful accounts of Indian wealth in jewels which excited the cupidity of Europeans had a basis in fact, according to a study of Indian mining by Sydney H. Ball, published by the Bureau of American Ethnology of the Smithsonian Institution.

He made use, Mr. Ball finds, of at least 84 kinds of gems and artificial stones and his acquaintance with minerals suitable for decorative purposes exceeded in number that of the peoples of Europe and Asia at the time of the discovery of America. The Indian also was the first to use platinum.

Like most primitive peoples the Indian saw in gems and decorative stones not only beauty but the supernatural and awe-inspiring. Among the pre-Columbian aborigines of Ecuador a large emerald was worshipped, and rock crystal and jasper appear to have served the same purposes among certain Peruvian tribes until they were forced to adopt Inca sun worship.

Diamonds, according to one account, were used by a tribe of Brazilian Indians as playthings for their children. Emeralds were used ornamentally in Colombia, Venezuela, Ecuador, Bolivia, Peru, and Panama. The Colombian emerald mines had been worked for a long time before the Spaniards conquered the country. The mining season was inaugurated with religious ceremonies and only certain persons were permitted to dig for the gems.

Eskimos believe that quartz formations are ice so solidly frozen that it has become stone.



Makes old oils and greases better than new for the Army

USED OIL

From Crankcases Reclaimed In Mobile Unit

A mobile oil refinery designed to purify used crankcase oil from more than 3000 military vehicles per month received its first test under maneuver conditions in South Carolina. Capable of refining approximately 200 gallons of used oil per day, the unit turns out a product which Army experts consider as good as, or superior to, the original oil. Impurities, such as water, gasoline, and grime, are removed during the process.

The used oil is dumped into a 100-gallon vat where it is mixed by an electrical mixer with Fuller's earth, a compound which absorbs the impurities. The mixture is then drawn by vacuum into a retort tank where it is heated to a temperature of 650 degrees. Gasoline, water, and other liquid impurities vaporize under this heat and are drawn off, also by vacuum, into a condenser tank where they are returned to a liquid state. The liquified impurities are then removed into a dilution tank. The oil, still at 650 degrees, is run through 50 feet of coils to cool, and then back into a tank. After the mixture has been cooled down to about 325 degrees, it goes into a cylinder where presses separate the Fuller's earth from the newly-refined oil. The viscosity of the oil depends, mainly, on the original product, but operators of the mobile refinery reveal that tests have shown the average weight to be around S.A.E. 30.

At present, the refinery accepts all oil and grease waste, including used crankcase oil, transmission grease, and other oil derivatives. The loss during refining is estimated at about 10 percent but operators believe that, given only crankcase oil drawn from vehicles, the loss in bulk would not exceed 5 percent.

The refinery carries its own generator mounted on a trailer, but the mechanism is designed to operate on either A.C. or D.C.

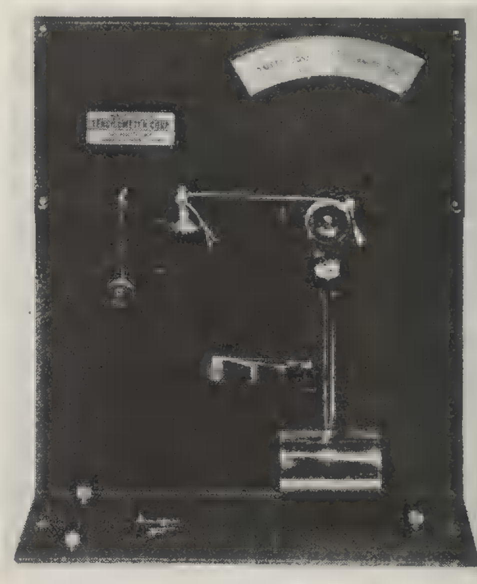
TIRED TIRES

Have Weak Cords in Carcasses

Tires get tired. After several thousand miles of use, the tensile strength of the tire cord begins to diminish. As the tire mileage increases, the danger of blow-outs increases. The loss of strength of the tire cord is called "cord fatigue."

To test the tensile strength of cord in a tire, a scientific and accurate device has been perfected. Called the Tensile Meter, this machine is gradu-

ated in pounds and has a dial divided into three zones—green for safety, orange for caution, and red for danger. When the cord is broken, the hand remains in a stationary position and indicates the tensile strength of the cord. If the hand remains in the safety zone, this indicates a cord test of over 12 pounds; if in the caution zone, the cord will test between 10 and 12



It shows if tires are tired

pounds. Should the results find the hand remaining in the danger zone, the cord tests below 10 pounds and the carcass is not safe or suitable for retreading. The cord to be tested can easily be removed from the tire from the inside splice where it overlaps. Either fabric or rayon cords can be tested.

PROTECTING

Film For Record Cards Of All Kinds

RECORD cards that must be referred to frequently can be protected from dirt and moisture by covering the surface with a new film manufactured by Seal, Inc. The film, which is applied by an electrically heated device, is practically invisible, is flexible, and is moisture-proof. Temporary notations can be made on the surface of the film with a colored wax pencil and then wiped off.

LENS

Automatically Keeps Objects in Focus

ALTHOUGH the living eye, with its elastic lens, automatically focuses objects at varying distances, optical engineers have looked askance at many ingenious proposals to accomplish this purpose in a photographic lens. But a four-element motion picture lens has now been de-

signed by Bausch & Lomb in which one double-concave element is electronically oscillated on its axis by means of a special cell mounting developed by P. Stanley Smith, a New York radio engineer.

The oscillating element is confined to a movement of three-tenths of a millimeter but the oscillations are at the rate of 23,200 times per minute, thus continuously altering the focus so that all objects are uniformly in register from four feet to infinity. Although all objects are slightly softer in focus than with conventional lenses, many photographers regard this as an improvement.

The new oscillating lens cannot be incorporated in hand cameras.

PHOSPHORESCENT

Paint For Use

In The Home

MANY are the uses to which phosphorescent paint can be put in the home, the home workshop, and even in offices and manufacturing plants. Dangerous corners can be spotted or outlined with paint that glows in the dark, electrical switches can be coated with the substance, house numbers can be made to glow in the dark, photographic dark room equipment can be painted, and so on.

Now available under the name of Lumi-Tone Phosphorescent Paints is a material which is easily applied and which, if covered with a protective coating film which is available with the paint, can be used out of doors or in locations where high humidity prevails.

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FREIGHT—Motor trucks carried 9 percent of the nation's freight moving on wheels in 1940, according to data compiled by the Equitable Life Assurance Society.

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BROWN EVERGREENS

May be Due to

Natural Causes

THE browning or rusting of evergreens, especially arbor-vitae and pine, must be quite general, judging from the numerous inquiries received at the State Experiment Station at Geneva, New York, from home owners who are alarmed over their ornamentals, says Dr. F. L. Gambrell, Station entomologist. Generally, the browning of evergreens during the fall is a natural phenomenon and is nature's way of pruning these trees, says this authority.

"In the early fall the amount of browning may vary considerably during different years," says Dr. Gambrell, who continues as follows: "Commonly, this condition is quite natural, that is, it is a case of natural shedding or pruning of the older leaves and branches and is comparable to that which occurs on deciduous plants. Fall browning is particularly noticeable on arbor-vitae and may also be observed on pines in the form of browning and shedding of the 3- and 4-year-old needles. Occasionally, the 2-year-old needles fall, but this may be due to some organic agency or adverse weather conditions."

A browning of evergreens may occur in the early spring and again in the summer, says Dr. Gambrell, and in such cases several factors may be involved, some of which require care to prevent serious injury. If browning occurs in late February and early March, it may be attributed to a drying out while the soil is still frozen and the tree unable to replace the water lost by the needles. Exposure to the prevailing winds and direct sunlight generally accounts for this injury which may be reduced by shading or screening the trees wherever this is practical.

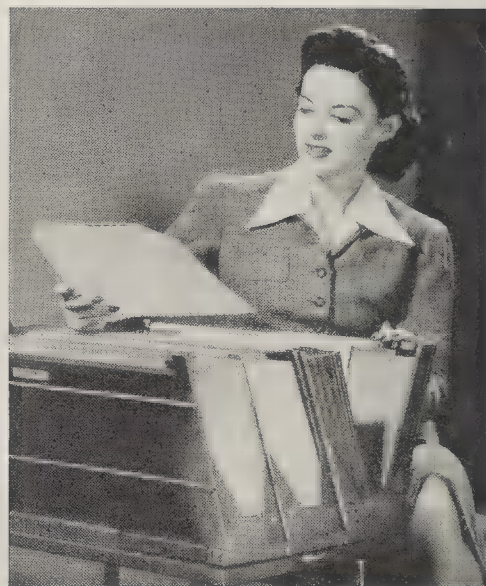
Summer browning of evergreens is most generally caused by insects, with the spruce mite as a common source of trouble, especially during hot, dry weather. This insect attacks other types

of evergreens as well as spruce and can be detected upon close examination as tiny reddish creatures crawling about the trees. Dusting sulfur gives good control. Summer browning may also be due to scale insects, root weevils, spruce gall aphids, unfavorable or poorly drained planting sites, hot, dry weather, or the failure of newly transplanted trees to become established.

INDEX SYSTEM

Uses Plastic Instead of Metal Strips

Strips of Tenite are replacing aluminum in the new Visi-Record card index system, and are said to improve its efficiency. The strips are continuously extruded and then cut in lengths to fit



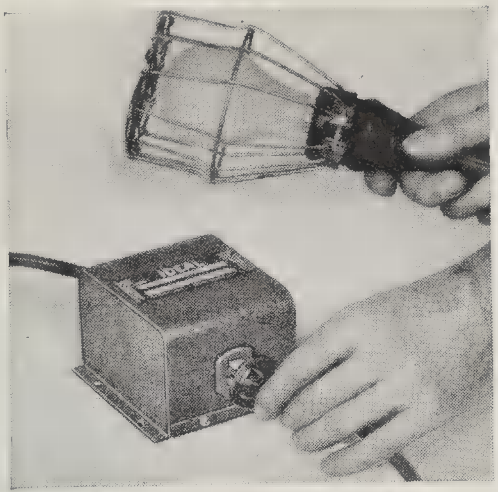
Colored plastic in file system

the vertical edges of the divider cards. Once snapped and riveted into position, they serve to support the cards and protect their edges against wear and tear from handling. By using different colored strips, indices and sub-divisions of the system can be identified at a glance. The non-resonant quality of Tenite makes for quiet operation.

LAMP

Operated At Low Voltage Increases Safety

Where electric extension lights are used in the shop and factory, occasional injuries are caused by shock, particularly when such lights are used in wet locations. Such danger can be eliminated by the use of a six-volt bulb in the extension light, supplied with current through a transformer. This arrangement is commercially available in the form of the Ideal Lo-Volt Transformer shown in one of our photographs. The primary lead plugs di-



Low voltage, high safety

rectly into any 110 volt A.C. supply; the secondary lead delivers current at a harmless pressure of six volts which cannot be felt even though it is short-circuited directly through the body.

PROOF?

The Joke was on Bischoff, But Too Late

BISCHOFF, one of the leading anatomists of Europe, thrived some 70 years ago. He carefully measured brain weights, and after many years' accumulation of much data he observed that the average weight of man's brain was 1350 grams, that of a woman only 1250 grams. This at once, he argued, was infallible proof of the mental superiority of men over women. Throughout his life he defended this hypothesis with the conviction of a zealot. Being the true scientist, he specified in his will that his own brain be added to his impressive collection. The postmortem examination elicited the interesting fact that his own brain weighed only 1245 grams.—*Journal of the American Medical Association.*

MOST NOTABLE

Which are the Outstanding Scientific Instruments?

HISTORIANS of the future, we believe, will choose the cyclotron and the electron microscope as the most notable new instruments of the age. Both are remarkable because they contribute to several fields of science. By its massive design and large dimensions, the cyclotron has undoubtedly captured popular imagination; but from a strictly technical point of view it might be argued that the electron microscope is a tool of wider application. Physicists, biologists, engineers, chemists, bacteriologists—all have problems whose solution is almost assured.—*Prof. Thomas H. Osgood in Journal of Applied Physics.*

Night Vision

A British Army Medical Officer Considers a Subject of Vital Interest to Aviation in Particular

ALEXANDER KLEMIN

Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

To be able to see in the dark is quite an important matter to night-fighter pilots, the crews of night bombers, spotters of the anti-aircraft service, drivers of vehicles by night, and others. It will be equally important to civilians as they become Air Raid Wardens. Therefore, we read with great interest an article on night vision, by Captain Brian St.J. Steadman, of the Royal Army Medical Corps, recently published in *The Aeroplane*.

The part of the eye that is sensitive to light is called the retina—the innermost of three coats that form the eye ball. In one of the outer layers of the retina lie two types of cells known as cone cells and rod cells, both distributed over the retina. A complex substance known as visual purple is present in the rod cells, and it has the remarkable property of being bleached on exposure to light but regenerating rapidly in darkness or semi-darkness. Now here, in Doctor Steadman's words, is the explanation of night vision:

"Vision depends on two mechanisms. One, governed by the cone cells, is concerned with form vision and color vision and functions only in bright light. This is known as the photopic mechanism. The other depends on the rod cells and the presence in them of visual purple. It is concerned with appreciation of light and movement and functions in conditions of semi-darkness. This is known as the scotopic mechanism. Everybody knows that after going from bright light into semi-darkness one can see very little at first, but that after an interval one begins to see more clearly. This is due to an increase in sensitivity of the rod cells caused by the regeneration of visual purple and is known as dark adaptation."

This dark adaptation increases rapidly after we are plunged in darkness or semi-darkness. At the end of one hour the sensitivity of the retina may be increased between 50,000 and 100,000 times.

What should be done to increase the night vision of those about to engage in the specific tasks we have mentioned? First of all, they should wear dark goggles or stay in a completely dark room for 45 minutes. To test whether one's eyes are dark adapted, a star should be looked at directly, and then the line of vision should be deviated slightly. If the star appears brighter in the second case, then the faculty of night vision is in full use. The reason for this is that there are no rod cells in the retina at the central point, that part used for clear vision during the day.

The quality of night vision varies in individuals and some people suffer from night blindness, which may be caused by a deficiency of visual purple, due, in turn, to a deficiency of vitamin A in the diet. Night blindness may be cured by eating liver, carrots, and so on. But, unfortunately, no amount of food containing vitamin A will improve any lack of night vision faculty that a person may have. Dr. Steadman explains it this way: "Experiments have shown that it is useless for people with a poor night vision standard to attempt to bring about an improvement by eating two pounds of raw carrots a day."

Since selected food is no cure, the best that the British have been able to do for their night-fighter pilots is to devise tests for the standard of night vision and to give selected candidates a course of exercises. The quality of night vision may be improved by constant practice. With eyes fully dark adapted, an endeavor should be made to recognize at night the outlines of trees and buildings against the sky, both with and without field glasses. Commencing with familiar outlines, the distance may be gradually increased and use made of unfamiliar outlines. Large letters or diagrams of aircraft may also be employed. The amount of training done in this way, and its helpfulness, is determined by the individual himself and depends largely on his keenness.

SHOP LIGHTING

Fluorescent Tube Used in Portable Unit

With all the good will in the world, our aviation notes seem to drift away from the progress of aviation science to the progress of aviation manufacture. One reason is that the most important scientific advances in aeronautics are apt to go on the secret list, to discuss

which means the risk of dire penalties. Another reason is that emphasis today is on production and practical advance rather than on radical development.

Thus we can and should devote attention to the use of a portable fluorescent light for night work in the aircraft plant. The new light is encased in a tube of transparent "Lucite," methyl methacrylate resin. The light is of low

It brightens the corners

weight, handy, and gives off spherical lighting so that shadows are eliminated. It is cool, which is a real advantage. One of our photographs shows a foreman using the light while working on a Lockheed P-38.—*A. K.*

"HAPPY" SPEAKS

And Tells Something of the Army Air Corps

THE first Chief of the Army Air Force, Major General H. H. Arnold, is frequently spoken of as "Happy Arnold," but his character and energy are such that the nickname does not fully become him. General Arnold, a veteran flier with a thorough knowledge of every phase of military aviation, is just the man we need today when aviation is all-important in our war plans. His resumé of Air Corps developments for the last year or so is significant and encouraging.

Fighters are the best defense against air attack, but bombers alone can lead to victory. "The heavy bomber," says General Arnold, "in which type we lead the world by several laps, remains the backbone of air power." We need only recall the Boeing Flying Fortresses to agree with the General. With their pressurized cabins and supercharged engines the Boeings can operate at over 40,000 feet altitude where they are, for the moment, immune to attack by pursuits or anti-aircraft guns. The fighter, with

its superior maneuverability, can outfight the bomber, but its ceiling will have to be boosted. Dive bombers have become synonomous in the public mind with German aviation; but as a matter of fact it was the United States Navy which first introduced dive bombing and it is the Curtiss-Wright Corporation which has built the world's best dive bomber.

Another achievement of the Army Air Corps lies in its ferrying program. The Air Corps Ferrying Command takes planes, with rare accidents, from the West to the East Coasts, from the East Coast to Greenland, to Iceland, to Georgetown in British Guiana. Here is what the General says: "Except for our short-range planes, the Air Corps Ferrying Command is capable of operating around the world. Its navigators are studying globes, not maps, and they would take a bomber to Tibet or Little America on 48 hours notice."

Since Crete, there has been a general feeling that glider-born troops have proved their value. The Air Corps is keeping step with this new development also by the procurement of gliders and by training pilots in gliding and soaring. Army and Navy alike are interested in the towed glider capable of transporting many armed men. Altogether, General Arnold's message is very encouraging. It shows that our Air Corps is wide awake, following every air development of the war.—*A. K.*

TELESCOPE MAKING?

Doctor Urges Pilots to Take Up Hobbies

TODAY'S high and fast flying pilots will take up stamp collecting, gadget making, or the study of foreign languages if they listen to the advice of Mayo Clinic's Dr. M. N. Walsh.

The modern pilot's nerve-splitting profession not only requires that he groom his body like Joe Louis, but that he save every possible milligram of his nervous energy by learning how to relax, Dr. Walsh declares. To combat excess drain on nervous energy, he urges perfect physical condition aided by frequent rest periods and hobbies. "The importance of hobbies in securing mental relaxation is much underestimated. The chief value of hobbies . . . lies in their capacity to release pent-up nervous tension. The most satisfactory hobbies are those which involve making something with the hands or forming collections, so that the individual can enjoy the feeling that he has created something worth having, and can spend a quiet and restful hour with his hobby in forgetfulness of the worries of his daily occupation."—*Science Service.*

Industrial Growth

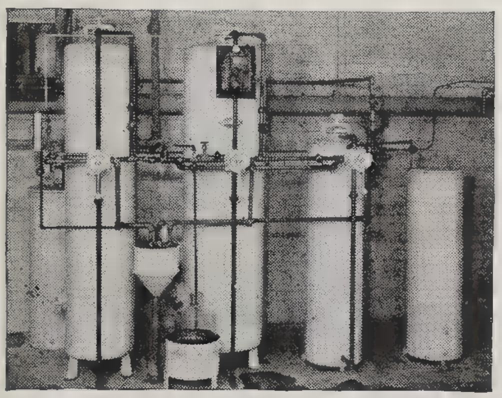
New Products and Processes That Reflect Applications of Research to Industrial Production

"DISTILLED" WATER

Obtained By Process Using No Heat

WHERE industrial operations require the use of pure water for any of a number of purposes, distilled water is usually used. For such operations it is now possible to obtain pure water comparable to single distilled water without the use of heat and at a small fraction of the cost of distilled water.

This "synthetic distilled water," as it is called by the Illinois Water Treatment Company, manufacturers of the equipment which produces it, may be obtained with as low as four parts per million of dissolved solids.



Complete heatless water "still"

The treatment process uses equipment which passes the water successively through two beds of special minerals, the first of which removes, by base exchange, the positive, or metallic ions, such as calcium, magnesium, sodium, or iron, substituting hydrogen. The effluent from this tank is acidic in that the hydrogen ion combines with the negative sulfate, chloride, and nitrate ions. (The carbonates form H_2CO_3 which passes on through as CO_2 and water, and the CO_2 can be very largely dispelled by aeration if its presence is undesirable.)

This acid water passes to an anionic reactor tank where the negative ions (chlorides, sulfates, and nitrates) are removed and replaced by the hydroxyl ion. The H and OH combine to form water, giving a final effluent which compares very favorably to commercial single distilled water.

The equipment has both an hourly capacity or flow rate in gallons per hour and an overall capacity when the minerals become exhausted and are regenerated similarly to a water softener. The chemicals used in regeneration are commercial acid and soda ash which are cheap and readily obtainable.

It is stated that this "synthetic distilled water" is already being used in many industries where processes call for extremely pure water. In other industries the low cost of "distillation" makes it possible to take advantage of this purity where cost was formerly so high as to be prohibitive.

JACK

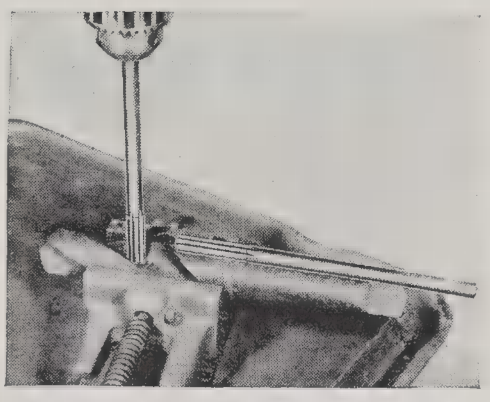
Wedge Blocks For Leveling Machines

A SIMPLE arrangement of two iron castings and a shouldered screw, placed under a machine, makes it possible to level the equipment quickly and accurately. The two iron castings are wedge shaped, the head of the screw bearing against a slot in the lower casting. As the head of the screw is turned, it forces the upper casting to slide on the lower one, thus increasing or decreasing the height of the assembly and hence making it possible to bring the machinery to exact level. The device, manufactured by Enterprise Machine Parts, is known as a "Machine Jack."

REAMER

Operates in Hardest Steels

A NEW type of reamer, made of Hardsteel and capable of reaming hardened steel of any degree of hardness



Reamers described above can be used even on hard steel drill stock

without annealing, has been developed by the Black Drill Company. The reamer, made of the same secret-process metal which is used in Hardsteel drills, [See page 93, February 1942 Scientific American.—Ed.], is designed to operate in the same manner as the drills and, it is claimed, will easily outlast any high-speed reamer now in use. While the ordinary high-speed reamer will ream metals up to 35 degrees Rockwell, Hardsteel reamers will ream metal of any hardness up to and including nitrided surfaces, without unusual wear. They have been used successfully on carburized, oil hardened, water hardened, cyanided and nitrided pieces of high carbon, high chrome, and high-speed steel.

The accompanying illustration graphically shows the possibilities of Hardsteel reamers. A hole drilled by a Hardsteel drill in a twist drill, with a Rockwell 60 C., is being reamed without effect on the reamer.

ACID INDICATOR

Used in Controlling Industrial Process

INDICATIVE of the possibilities of the solu-bridge controller for industrial purposes is the recent application of this unit, manufactured by Industrial Instruments, Inc., to the processing of mineral oil. Mineral oil is treated with concentrated sulfuric acid in large vats. At the end of the treatment cycle the concentrated acid which has not entered into reaction settles to the bottom of the vat. Above this there is sludge, with treated oil above the sludge. The sulfuric acid is first drawn off from the bottom of the vat, followed by the sludge, and finally the treated oil comes through. The conventional method of ascertaining when all the acid and sludge have been removed is by means of a by-pass pipe and visual observation. The operator at times does not notice when the withdrawal of sludge has ended and treated oil starts coming through.

When the problem was first put up to the industrial instrumentation engineers, their first step was to check liquids withdrawn from the vat by means of the solu-bridge. It was found that sulfuric acid read over 7 percent, the sludge approximately 0.2 percent, and the treated oil gave a reading of 0. Thus by placing a special conductivity cell in the by-pass line, and setting the indicator of a solu-bridge controller at 7 percent, the self-contained relay of the instrument closes and actuates an alarm when sludge begins to come through. Again, setting the indicator at 0.01 percent, the relay will close and give indication when oil starts to come through.

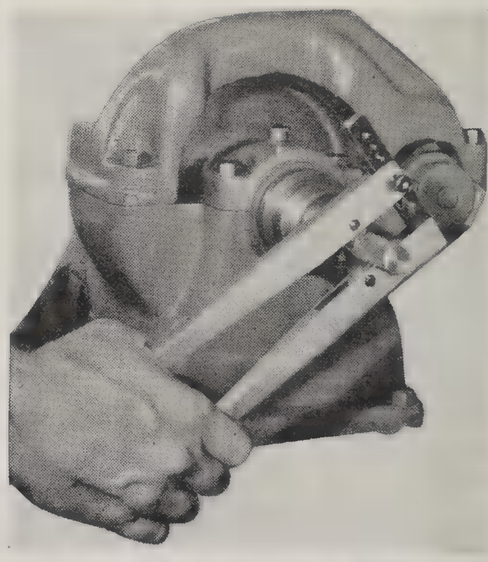
The solu-bridge controller is an electronic device which not only indicates the conductivity of a given liquid in any desired terms, but also, by means of its self-contained relay, actuates an external warning signal such as a flashing lamp or audible alarm. The relay can also be employed to control some suitable corrective means, such as opening or closing solenoid-actuated valves.

KNURLING

Plier-Type Tool Is Adjustable

KNURLED surfaces can be produced on metal rods having diameters between $\frac{5}{16}$ of an inch and two inches with a new adjustable plier-type knurling tool announced by the Pacific Specialty Supply Company.

Two knurling wheels are mounted on one arm of the tool and a third on a hinged arm which can be adjusted by means of a removable hinge pin. In use, the tool with its three knurling wheels is placed over the work and pressure is applied by hand to close the wheels against the work surface. The work can be rotated by any means as in a lathe or drilling machine, or it can be held in a vice and the tool revolved around it.



Hand knurling on a lathe

NOZZLE INSERT

Of Ceramic, for Air Blasting Equipment

AN extremely hard, abrasion-resisting ceramic, now being used instead of metal for the inserts of "Long-Lyfe" abrasive blast nozzles manufactured by American Foundry Equipment Company, is claimed to have a hardness and density that is superior to many of the metals now being used for this pur-

pose. Its manufacture is not affected by the present scarcity of certain alloys.

Economy of operation is achieved with these inserts because the cost of compressed air is kept at an absolute minimum since the nozzle wears slowly and evenly. Also, because the original orifice is preserved without appreciable wear, even after hundreds of hours of service, the contour of the blast stream is maintained and the work is cleaned faster and more uniformly.

Additional features of this nozzle include: High finish bore; no soft spots to start uneven wear; non-metallic, thus reducing static to a minimum; does not "bell out" rapidly; excellent mechanical strength.

SWITCH

Foot Operated For Start-Stop Operation

A foot-operated switch which solves many problems of frequent start-and-stop operations of machines, incorporates tungsten contacts which are held in open position by spring pressure but are brought together to close a single-pole circuit when pressure is applied to the top of the rubber housing of the switch. The switch responds to the slightest down pressure of the foot; it is claimed that less pressure is required than is applied to the average automobile accelerator. Rated at 1000 watts, these switches have a conservative guarantee, by the Nathan R. Smith Manufacturing Company, for 40,000 operations per year. They can be used to control the operation of any small machinery within the rating range.

SANDING

Machine For Use On Inner Surfaces

For use in production work which requires sanding of the inner surfaces of wood grilles and other shapes, a unit machine has recently been developed by the J. M. Nash Company. Built into this machine is an adjustable chair for the operator and an adjustable foot pedal which controls the tension of the continuous sanding belt.

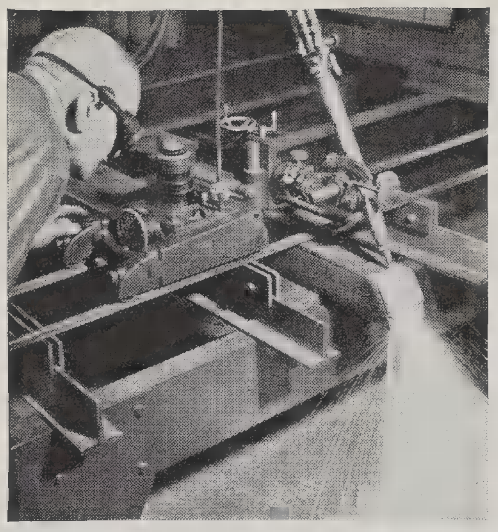
For inside sanding

One of our photographs shows this sanding machine in use. The operator can apply the work to either the upper or lower surfaces of the belt. When he finishes with one interior opening, it is only necessary to depress the foot pedal, whereupon the belt action stops and the belt can be released from the pulley nearest the operator. The work piece is then removed from the belt, the belt is introduced into another opening to be sanded and then slipped back on the pulley. Releasing the foot pedal tightens the belt and starts it in motion.

GAS CUTTING

Torch Holder Is Adjustable

A new torch holder has been developed for the Radiagraph gas cutting machine by which the torch can be set at any angle in vertical and horizontal planes and can be adjusted laterally and vertically with reference to the vertical support on the machine housing. The arrangement facilitates application of the machine, which travels on a track for feed movement over the work. The new unit is known as the Protractor Torch Holder.



Cutting at angles—with gas

The torch is held in a clamp on a spindle secured at right angles with a supporting arm. The arm rotates on a horizontal support at the end of a slide riding in a bracket. The bracket mounts on a vertical post on the machine housing. The spindle rotates and clamps at a desired angle and is set with the aid of a protractor in the spindle assembly. The arm and the end of the slide also are graduated for rotation of the former to an angle and are clamped in set position. The bracket moves the arm up or down when a crank is turned, in or out when a handwheel is operated.

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Stroboscopic Multiflash

STROBOSCOPIC multiflash photography is the term used by Gjon Mili, engineer-photographer, to describe the method of making such pictures as those reproduced here. To the already familiar method of multiflash, which involves the use of several flash sources to make a single picture, Mr. Mili adds multiple exposure for recording several images on the same plate.

Mr. Mili, who recently exhibited 50 prints at The Museum of Modern Art in New York City, in the first showing of his stroboscopic flash work ever held, sees in stroboscopic multiflash the nearest approach to what he considers a faithful method of photographing dancers in action.

"The dance is an expression in time and space," he says. "Accordingly, in making a record of the dance, in order to retain its quality, a motion-picture camera should be employed. A single photograph, however fortunate its composition or its expression of feeling, can at best suggest only the mood without indicating the line of movement or the phrasing. In order to record an entire movement on a single plate, use was made of the technique already known as stroboscopic multiflash photography."

Employing a 5 by 7 Deardorff studio-type view camera, Mr. Mili describes his procedure as follows:

"The camera is held open throughout the period of a phase while lights equipped with Edgerton high-speed tubes are flashed repeatedly—in order to impress a multiplicity of images on the same plate. The pattern can be changed at will by altering the rapidity of the flashing—by accelerating or retarding it; it is this controllable multiflash element which can make possible a truly artistic presentation of dance movement.

"Dance in Movement"

"The majority of the patterns exhibited were achieved with the aid of three lights which flashed at intervals from 3 to 15 flashes a second, depending on the speed of the movement. The camera was operated at aperture stops ranging from $f/5.6$ to $f/16$."

The results achieved have both pictorial and scientific appeal, sometimes in combination, sometimes one or the other. Rapidity of movement is the first requirement, beauty of movement secondary, but essential if pictorial appeal rather than pure fact-finding is the result desired. Because of the extreme speed

Markova—by multiflash

of the light, a fuzzy image is hardly possible; only poor focusing will cause lack of sharpness.

In the single stop-action photographs included in the show, when 3 to 12 single flash Edgerton units were employed, Mr. Mili tried to catch the dancer at the very height of an intricate whirl or leap. In the case of the stroboscopic multiflash photographs, however, he attempted to show a complete sequence of movement that included not only the most dramatic split-instant action but the series of split-instant actions that preceded and followed the "main event." In other words, his multiflash shots are the still-picture approximation of the motion-picture record.

Thus, he shows the accordion-like multiple movements of a dancer, or the spider-web filaments of a human cartwheel split into segments as it flashes through space.

For Minimum Blow-ups

In making tests of a new fine-grain developer, the painstaking worker will try "blowing" the negative as far as it will go short of the image falling apart. But what good does that do if, holding onto small grain size, the image actually melts away as to quality? More reasonable would it be to enlarge the negative, or a reasonable portion of it, to the 8 by 10 or 11 by 14 print you normally require. If the result is good after this test, you should be satisfied; if it is poor, then you may abandon this particular "soup" and try another or give the first a further chance by checking back on yourself to see if you followed the manufacturer's instructions and recommendations as to time, temperature, and so on.

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What's New

In Photographic Equipment

Kodak All-Metal Printer Model 2 ($19.75): Takes negatives from 35mm to 4 by 5½ inches. Has four adjustable, inch-wide, margin masks. Permits strip printing of many popular sized roll films; provision for introduction of printing controls such as ground or opal glass. Measures 10 by 8 by 6 inches. Includes as supplementary feature ruby Kodaloid scales illuminated from below by printer's ruby safelight. White etched scales easily read.

Kodak Testing Outfit for Acid Rinse and Fixing Baths for Paper ($1): Compact, two-bottle kit, one for acid rinse, the other for fixing bath.

General Electric Blackout Flash Bulbs: Small bulb called G.E. "mighty midget" blackout photoflash lamp No. 5-R, identical in size and shape with Mazda "mighty midget" No. 5. Large blackout flashbulb, identical in size and shape with G.E. Mazda No. 21 photo flash lamp, known as G.E. blackout photo flash lamp No. 22-R. Bulbs have special purplish-black coating, whose characteristic is ability to screen out visible light, yet letting through the infra-red. Lamps are used in conjunction with infra-red film.

"Japs Bomb U.S.A.!": Movie depicting historic surprise attack by Japan upon Hawaii and incidents that led America into war, made available by Castle Films in five sizes and lengths, three 16mm editions, two 8mm editions.

Blue Mighty Midget No. 5: "Peanut" photoflash now available with blue coating for use in color photography. Color coating has same characteristics as that of G.E. No. 21B, matched by Eastman to color characteristics of daylight type Kodachrome.

Solar Mercury Tri-Switch ($5.50): For use with double contact socket and double filament bulbs to provide selective lighting in projection printing. Light intensities adjustable for 50, 100, or 150 watts in accordance with density of negative. Designed for tabletop use. Single throw, double pole type, with levers operating the mercury contacts.

Baylee Cine Color Kit ($6.50): Contains neutral density polarizing filter; Type A filter to convert indoor Kodachrome for outdoor use; Kodachrome haze filter to absorb ultra-violet rays. Filters housed in leather kit, which also includes all-metal sunshade and filter holder combination. Kit fits practically all 8mm and some 16mm movie cameras.

Willoughby Exposure Record Book (25 cents): Contains printed forms listing various data in connection with exposure and processing, gummed for pasting on negative envelopes. Offered as convenient method of keeping exact records.

John-Baylee Neutral Density Polarizing Filters: Made of precision ground optical glass to darken skies and eliminate glare and reflection, specially recommended by manufacturers for use in color photography. Available in all sizes; those fitting Series V and VI in the Eastman Kodak series list at $2.90 and $3.40, respectively.

Eastman Electric X-Ray Timer ($15): For use in processing X-ray films. Designed for timing in ¼-minute intervals for periods up to 10 minutes. Six-inch translucent Tenite dial with opaque markings read in silhouette; dial illuminated from within like safelight. Convex glass protects dial and hands of timer. All controls on top. Repeat timing. Operates only on 60-cycle 105 to 120-volt A. C. Housed in case of die-cast metal, finished in smooth dark-grey enamel. Included is 48-inch rubber-covered electric cord, with plug.

8mm Rental Service: Initial listing of 75 subjects consisting of features, cartoons, sport shorts, travel subjects, musicals, and novelties, announced in Bell & Howell's 1942 edition of catalogue of recreational films.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

CIVILIAN DEFENSE

By Lt. Col. A. M. Prentiss

THE means and methods of air attack, the effects produced by each, and the scope and character of their threats to civil life. Detailed to the Chemical Warfare Service since 1917, writer of *Chemicals in War,* the author discusses and factually describes civilian protection against high explosives, incendiaries, gases. Likewise, organization of aircraft warning for both active and passive defense; necessary protective services for the public; methods of protection for homes and industrial establishments; probable influence of civil air defense on our national life and future development of large cities, including relative present safety in tunnels, subways, cellars, and skyscraper basements, roofs, and middle stories. Of the utmost importance to everyone; vital for those responsible for the safety of others. (334 pages, 6 by 9 inches, 42 illustrations.)—$2.85 postpaid. —*A. D. R., IV.*

MODERN PLYWOOD

By Thomas D. Perry

IDENTIFIED for more than 30 years with plywood manufacturing, the author of this book brings to his subject an intimate knowledge of the technicalities as well as the practical applications of this material which is finding more and more uses in modern industry. Plywoods are conveniently classified into types and techniques of manufacture, are fully and effectively described. An excellent bibliography is provided. Mr. Perry is also the author of the aricle "Rolling Off a Log," published in this issue of SCIENTIFIC AMERICAN. (380 pages, 6 by 9 inches, 188 pertinent illustrations.)—$4.60 postpaid.—*A. P. P.*

MATHEMATICS—ITS MAGIC AND MASTERY

By Aaron Bakst

SUGAR-COATED approach to algebra, geometry, trigonometry. The sugar coating consists of brightness, humor, and downright inherent interest. This book has no text-book earmarks, but was written by a human being. You not only learn these branches of mathematics, but are beguiled along the way by an immense collection of mathematical oddities, time-savers, short cuts, recreations. Of course, it is not altogether painless—another way of saying that this is no freakish, frivolous book to be taken lightly; it is pretty solid stuff; an investment. Simply, the author saw no reason to be dull, if a thing could be made bright. (790 pages, 5½ by 8½ inches, illustrated.) —$4.10 postpaid.—*A. G. I.*

THE STORY OF VARIABLE STARS

By Leon Campbell and Luigi Jacchia

ONE of the new Harvard books on astronomy. Aimed at serious amateur astronomers. Amateur astronomers who wish to see what variable star work for the semi-professional is like, and to understand the background of the subject of variable stars in general, will find the account in this book, the senior author of which is the well-known patron saint of the variable star observers in this nation. The book is thoroughly practical—gets down to cases. Chapters: How Variables are Found; Observing the Variables; Using the Observations; Pulsating Stars; Red Variables; Explosive Stars; Erratic Stars; Stellar Eclipses. (226 pages, 5¾ by 8⅜ inches, 82 illustrations.)—$2.60 postpaid.—*A. G. I.*

BUILDING INSULATION

By P. D. Close

WRITTEN by a former Technical Secretary of the Americal Society of Heating and Ventilating Engineers, this is a book that gets down to particulars; its reader, or serious student, would carry away a pretty solid knowledge of the physical science behind building insulation as well as the practical aspects. A meaty book, technical, but not abstruse. It lists the various brands of insulation and names names. (328 pages, 5¼ by 8¼ inches, well illustrated.)—$3.10 postpaid.—*A. G. I.*

THE COLORADO CONQUEST

By David O. Woodbury

BOULDER DAM is only the last chapter of this rapidly running account mainly of the everlasting fight, fight, fight in the winning of the sub-sea level Imperial Valley from the ever-threatening Colorado River, termed the "Red Bull." First, projects. Then defeats. Growth. Quarrels among men. Dark years. Floods. Struggle with the River. Tussle titanic. Defeat. More battle. More defeat, defeat, defeat. No hope but—fight on. Inundation. Tragedy. Fight on. Near

victory, then all lost again for the fifth time. Start again—fight with $1,500,000 and all for naught. Begin once more and, at last (1907), victory and prosperity—to be followed by internal troubles with crooks, politicians. Finally—the last quarter of the epic—Boulder Dam, and the Red Bull was cowed at last. The author is an engineer and explains the events with an engineer's knowledge, but the events were so dramatic that no novelist could improve on their cussedness. The account reads like a historical novel—especially where the old horse relieved himself copiously! You'll be able to put this book down—about 4 A. M. (367 pages, 5¾ by 8½ inches, illustrated.)—$3.10 postpaid.—*A. G. I.*

AUTOMATIC ARMS

By Melvin M. Johnson and Charles T. Haven

Comprehensively treating one of the most important factors of the present war, this book covers the true "automatic" arms, such as machine guns, machine rifles, and machine pistols, or submachine guns. Also, pocket pistols, shotguns, sporting and military rifles which technically may be described as semi-automatic, since they load automatically, but fire only a single shot with a single pressure of the finger. Beginning with earliest history and development of multi-firing arms and progressing to latest models, this publication tells how they work, how to keep them firing, how employed in combat. Appendices include table of weapon types, many operating diagrams. First named author is Captain in Marine Corps Reserve, inventor of semi-automatic rifle and machine gun which bear his name; second is noted arms collector and co-author of *A History of the Colt Revolver*. Invaluable and fascinatingly instructive. (344 pages, 6 by 9¼ inches, over 150 illustrations.)—$4.60 postpaid.—*A. D. R., IV.*

HE'S IN THE NAVY NOW

By Lt.-Commander John T. Tuthill, Jr.

On life in the Navy. A Bluejacket's Day; The Recruiting Office; The Training Station; Service Schools; Aboard a Battlewagon; the Fleet and its Auxiliaries; Submarines; Sick Bay and Health; Liberty—these chapters give the scope of this book, which is largely pictorial, but usefully informative in picturing what sort of life everyday Navy life is. (256 pages, 6½ by 9½ inches, many illustrations.)—$2.60 postpaid.—*A. G. I.*

WORKING WITH THE MICROSCOPE

By Julian D. Corrington

To fill an existing gap between two types of books on the microscope—the too advanced work for the professional and the too shallow work for the juvenile—this new work has just been written by the Professor of Biology at Washington College. In it, he goes progressively with the serious beginner from the very beginning all through explicit, practical chapters on: The Microscope; Temporary

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THERE'S SOMETHING IN THE AIR! is a four-page folder describing a number of units for solving ventilation problems in industrial plants. Such ventilation is demanded by conditions of smoke, fumes, dust, or simply stale air. *Oliver & McClellan, Inc., 30 Church Street, New York, New York.—Gratis.*

PRODUCTS, PLANTS, AND SERVICES of the Koppers Company are described in this eight-page folder, the text of which ranges from coals and coke to light oil plants and purification systems, from valves and couplings to piston rings and roofing. Two pages are devoted to the uses and characteristics of tar acids, tar acid oils, and coal tar solvents. *Koppers Company, Pittsburgh, Pennsylvania.—Gratis.*

INTRODUCTION TO RADIO is a sample lesson reprinted from an available radio text book. The lesson is complete in itself and will serve as an introduction to modern radio for beginners. *Supreme Publications, 328 South Jefferson Street, Chicago, Illinois.—Gratis.*

THE DIELECTRIC STRENGTH OF GLASS—AN ENGINEERING VIEWPOINT, by E. B. Shand, gives a general summary of the use and potentialities of glass as an insulating material in the electrical industry. Tables and data curves include disruptive strength, breakdown characteristics, dielectric breakdown data for glass, breakdown data for porcelain, and so on. *Corning Glass Works, Corning, New York.—Gratis.*

TELEVISION TRANSMISSION, by M. E. Strieby and C. L. Weis, is an engineering report of experimentation in the transmission of television signals over wire lines. Some of the general problems of wire transmission have been included in the discussion as well as the results of transmission studies on a system linking Philadelphia and New York. *Bell Telephone Laboratories, Inc., 463 West Street, New York, New York.—Limited Free Distribution.*

SAFETY CLOTHING FOR INDUSTRY is an 18-page catalog which describes and illustrates gloves and mittens, hand guards, arm protectors, asbestos clothing, welders' gloves and apparel, and other similar safety equipment for industrial use. *Industrial Gloves Company, 700 Garfield Blvd., Danville, Illinois.—Gratis.*

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THE PHYSICAL STATE OF THE UPPER ATMOSPHERE, by B. Haurwitz, is a 96-page summary of our present knowledge of phenomena above 7 miles—noctilucent clouds, meteors, light of the night sky, propagation of waves, variation of terrestrial magnetism, aurora, anomalous propagation of sound, composition and structure of the atmosphere. Technical in spots, popular in others. *Royal Astronomical Society of Canada, 198 College St., Toronto, Ontario, Canada.—75 cents.*

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

For a long time, this department has sought opportunity to reprint and thus make available to the average amateur a lengthy paper on the tests of the 82" mirror at the McDonald Observatory in Texas, written by Dr. J. S. Plaskett, late Director of the Dominion Astrophysical Observatory in Canada, originally published as *Contributions from the McDonald Observatory, University of Texas,* No. 1, later in *The Astrophysical Journal,* Vol. 89. The astronomer Plaskett was also an optician, acting as advisor on a number of large mirror jobs and as final acceptance tester for purchasing institutions.

The amateur who studies this paper will follow the tests exactly as the professional sees and makes them—and will discover no mysteries but mainly the same things he does on smaller mirrors, and some of the same old headaches. Perusal should flatter his vanity, also confirming him in his methods.

One professional astronomer, director of a new observatory, asked this department to suggest the names of men qualified to make the acceptance tests on a very large mirror. Dr. Plaskett was of course named, as were others; and then A. W. Everest and other advanced amateurs were suggested. The astronomer had had the same thought—for many amateurs do more mirror testing than any professional, and in this way become highly expert in the eye-detection and interpretation of shadow subtleties. It turned out that the chief practical problem was not about the amateurs *per se,* but the university's trustees: "What would *they* say if I nominated amateurs! They'd never understand. I'd never live it down." We suspect he was right. The word "amateur" has two connotations.

Dr. Plaskett's article, which will require close study, follows:

The Warner and Swasey Company, who have designed and constructed the mechanical parts of the Lick, Yerkes, Victoria, and other large telescopes, have never undertaken, until the contract for the McDonald Observatory was signed in 1933, to supply the optical parts for their instruments. The deaths of Dr. Brashear and Mr. McDowell, who had in recent years provided the optical parts required, and the desire to make the complete telescope, were probably the main reasons inducing this famous firm of telescope-builders to include an optical department in their organization. This was established in 1933 under the direction of Mr. C. A. R. Lundin, who had previously acted as chief optician for the well-known firm of Alvan Clark and Sons.

The optical shop was fitted with a grinding and polishing machine for the 82" mirror and with a smaller machine for a 57½" flat to be used in testing the 82". Work on the latter and on some smaller jobs occupied the time until the arrival of the 82" disk from Corning in October, 1934. Grinding was commenced on October 19, 1934; and nearly four years later the mirror was completed, on October 14, 1938. The figuring was not, however, continuous throughout the period, as in the hope of early completion the figuring with the full-sized tool was unfortunately continued so far that, early in 1937, the focal length became too short. Even though the parabolizing was nearly completed and the reduced focal length was within the range of adjustment provided in the mounting, neither the firm nor Mr. Lundin was willing to allow such a departure from the specifications. It required several months' work with the large tool to flatten the curve sufficiently, so that the final figuring—for the earlier close approach to the paraboloid was wiped out in the flattening process—did not begin until October, 1937. Twelve months can hardly be considered an unduly long time to figure an optical surface of this size in a newly established shop.

Early in 1936 I was asked by the Warner & Swasey Company to act as consultant in optical and other scientific matters connected with their instrument work, and in 1937 I visited Cleveland twice—once in May during the flattening process and later, in October, after the commencement of the refiguring. I was summoned again in March, 1938 when it seemed desirable to make a change in methods and remained, with two intermissions, consulting with Mr. Lundin until the mirror was completed on October 14.

During a visit, late in March, of Dr. Struve, the director of the new observatory, and two associates—Dr. Van Biesbroeck and Dr. Kuiper—a different method of testing was proposed, depending on measurements at the center of curvature from which a "curve of shape" was developed, the purpose of which was to give the true form of the surface with exact numerical values of the deviations from the paraboloid. The results from this method, which was extensively used and which will be more fully discussed later, were, however, at first disappointing; and early in May the 57½" flat, which had been given a very fine figure by Mr. Lundin a year earlier, was silvered and thereafter was used as the principal means of testing the surface of the 82" mirror.

It may safely be said that, after the flat was set up and the shadow pattern at the focus could be observed—the method which Mr. Lundin had always hitherto used in figuring mirrors—the

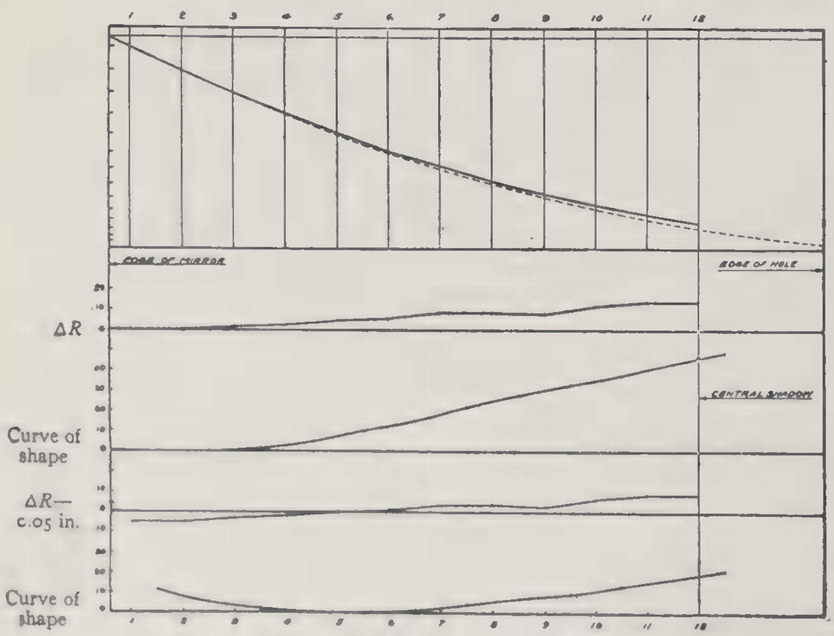

Figure 1: Curves of October 5, 1938

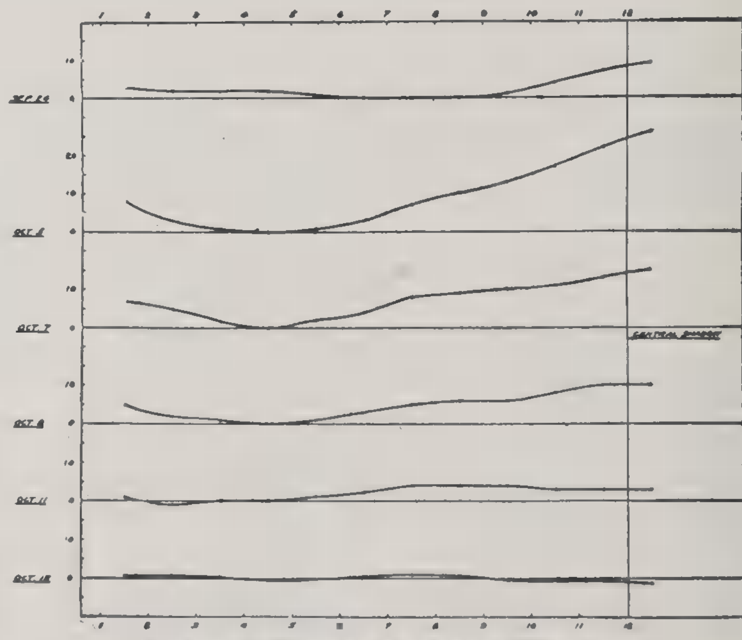
Figure 2: Curves of shape, 82" mirror

progress toward the final result was steady, if not quite continuous. As is probably the case with all optical work, especially large surfaces, various difficulties and occasional setbacks were encountered. It may be sufficient to mention first a sharply turned-up edge—much preferable, however, to one turned down—which required considerable handwork with small tools to reduce, at which Mr. Lundin is remarkably expert. A second difficulty was irregularity and lack of general smoothness over the surface, a problem completely solved by substituting for the full-sized tool a half-sized tool, with a long sweeping stroke.

The final figure came quite rapidly at the last, as can be seen in the graphs in Figure 2, where the units are millionths of an inch and where the curves of shape of September 24, when the half-sized tool had barely come into use, and those of the final week of figuring are given. Dr. Struve and Mr. Fred Pearson, of the University of Chicago, paid a visit of inspection on October 6, when, under the knife-edge test at the focus, the figure looked so smooth and uniform that they adjudged it as nearly finished. However, tests at the center of curvature next morning and formation of the curve of shape showed it as still undercorrected to the extent of 20 millionths of an inch, a whole wave, and work was continued. Progress on one day enabled an estimate of the required time of polishing to be accurately made, and on this basis the paraboloid was considered completed on October 12, when the curve of shape showed deviations only slightly larger than a millionth of an inch, an eighteenth of a wave. Tests at the focus showed a high central zone, which Mr. Lundin reduced to practical invisibility in four short hand workings on October 12 and 13. The mirror was inspected and accepted by Dr. Struve on October 15 and was then made ready for aluminizing, necessary to make the Hartmann test and to figure the secondaries. The mirror was taken out of the vacuum chamber on October 24 and set up in the optical shop, where the visual and photographic tests were completed.

The method of testing the surface was a modification of the well-known method of determining the center of curvature of a number of zones spaced uniformly over the surface and comparing these measured positions with those computed from the properties of the parabola. A cardboard diaphragm was placed in front of the mirror, containing 28 circular 1.5″ holes, spaced uniformly along a horizontal diameter at a separation of 2.5″. The innermost zone, No. 14, has a radius of 7.75″; and the outermost, No. 1, of 40.25″. A series of shutters before the openings, manipulated by a rod extending through a partition, enabled the zones to be opened at will without going near the mirror. The intersection of the converging pencils from a fixed artificial star was determined at first by an eyepiece and later, more accurately, by a knife-edge. Obviously, in this case, the departures of the intersections from the computed posi-

tions are double those of the radii of curvature and four times those at the principal focus.

The knife-edge is attached to a slide moved parallel to the optical axis by a screw, the positions of intersection being obtained by lines scribed against a straight-edge on a stationary aluminum plate, rigidly attached at right angles to the slide. The positions of the intersections were either directly compared with a standard series in the computed positions, or later, as the mirror approached completion, the separations of the scratches were accurately measured by dividers on a steel scale. A modification developed by Mr. Burrell consisted in plotting the positions of the zonal openings as abscissae and the distances of the corresponding intersections from that at the center of the mirror as ordinates. The method is illustrated in the upper part of Figure 1, containing the measures of October 5, plotted as a curve which can be directly compared with a normal parabolic curve drawn in a dotted line through the computed positions. Blueprints were made of the fixed parts of this diagram, and the observed curve could be rapidly laid down on one of these prints from the scratches on the plate, the positions of longer radius being above and of shorter radius below the standard curve. The curve was at first considered as indicating where glass should be removed instead of showing where the surface was too flat or too concave.

It was the purpose of the curve of shape proposed by Dr. Struve, Dr. Van Biesbroeck, and Dr. Kuiper to overcome this difficulty and to represent graphically the actual form of the surface and the exact deviations from the paraboloid. The method is simple, the tilt of the element of the surface 2.5″ wide, centered on any zonal aperture, being determined from the deviation of the intersection of the corresponding pencils from the computed position. The departure of the ends of this element from the paraboloid is thus obtained; and joining these ends together—in other words, alegebraically summing the departures consecutively across the surface—gives its true form, the factors being so chosen that the departures of the intersections from normal, hereinafter called *R*, in hundredths of an inch, correspond to millionths on the curve of shape and on the surface.

Unfortunately, this method is also subject to ambiguity, particularly at the edge of the mirror, as the curve only begins to give reliable information halfway between zones 1 and 2; furthermore, the general slope depends upon the choice of zero, or the starting-point of the measures. This latter point is illustrated in the central part of Figure 1 in the measures of October 5. The deviations of the intersections plotted at the top of the figure with respect to the parabolic curve are repeated directly below, but on a different scale, in the broken curve drawn with respect to a straight-line base. These deviations, in hundredths of an inch, are transformed into the smooth curve of shape immediately below, showing deviations from the paraboloid in millionths of an inch. In the lower pair of curves the broken curve is exactly the same as above, except that 0.05″ is subtracted from each measure, or the base line is lowered by 0.05″. The curve of shape, however, is quite different, as not only is the slope radically different, indicating an alternative method of reaching a parabola of slightly different focus by removing glass both at edge and center instead of the center only, but also the average curvature is changed. Notwithstanding these difficulties, which rapidly diminish as the paraboloid is approached, the method is of distinct value in representing the exact form of the surface and in giving numerical values of the departure from the theoretical curve.

As soon as shadow tests at the focus were available, early in May, they were used exclusively as a guide for the next working, as there was then no chance of ambiguity in the readings and the high zones could be accurately located and marked. The knife-edge shadow tests were supplemented and confirmed by the use of a Ronchi plate, where the condition of the surface was shown by the straightness and parallelism of the resultant bands. Measures at the center of curvature were transformed into curves of shape for Dr. Struve about once a week as a numerical record of progress until toward the end of the parabolizing, when it was felt desirable to check the shadow readings by measures at the center of curvature and by the formation of the curve of shape. For the last ten days or so, this was done after every polishing, as, although the shadow test recognizes very minute departures from regularity of figure, it is perhaps not so sensitive to very gradual changes such as those due to slight under- or overcorrection.

This was especially true in this instance, where the flat was a little over two thirds the size of the 82″, of which, hence, only a little over half, or just beyond the central hole, could be seen, and consequently the exact position of the knife-edge, its exact focusing, was uncertain, with resultant effect on the shadow pattern. As a result, though the shadow test was essential throughout to insure smoothness and regularity of figure and to determine where polishing was required, the final check on complete parabolization depended upon careful measures at the center of curvature and the resultant curve of shape. These were of great value during the last week of figuring, where the proper length of time for the next polishing was determined solely from past changes in the curve of shape. Thus, on October 11 (see Figure 2) the time required to complete the parabolizing, 1½ hours, was gaged correctly, as seen in the lowest curve, from the change produced by the two previous workings. And here again, the shadow test was essential, for otherwise the high central zone, which had no effect on the measures at the center of curvature, would have escaped notice.

(*To be concluded.*)

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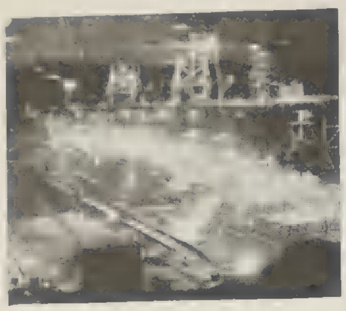
NINETY-EIGHTH YEAR

ORSON D. MUNN, Editor

APRIL • 1942



INTEGRAL part of California's Central Valley Project, described in detail on page 178, is Friant Dam, shown under construction in the reproduction on our front cover of a spectacular photograph taken at night under floodlights.

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OUR *Point* OF VIEW

BENEFITS OF WAR

IN no sense questioning General Sherman's terse and forever accurate summation that "War is hell," and with not the slightest Pollyannish inclination, we nevertheless point out that the present world-wide conflict of blood carries along with it an educationally constructive phase that will benefit immeasurably every citizen of this country. For the first time in history the men, women, and children behind the men behind the guns *must* learn how to take care of themselves and each other when under fire—just as the soldier, the sailor, the marine must do in the course of his training.

More than five million men and women in civilian life—and the number grows every day—are attending classes, clinics, and demonstrations to master the intricacies of first-aid and nursing, the science of fire-fighting, the mechanics of road repairs and demolition of dangerously damaged buildings, the chemical knowledge necessary for use in the decontamination corps, the mechanics and dangers of unexploded bombs and delayed-action fuses, the manipulation of emergency telephone switchboards, telegraph keys, radio equipment, and many, many other things which most of us have never before felt it necessary to know. Thousands of women, heretofore completely competent to drive automobiles, are breaking manicured fingernails and acquiring "grease-monkey" hands in finding out what motivates their cars, how to make emergency repairs. Business men from every walk of life feel physically better because of the regular exercises incident to walking the beats and engaging in other physical aspects of the training of the air raid warden, the auxiliary fireman and policeman.

The enormous scope of this sudden national hunger for knowledge of "how to do it"—particularly since Pearl Harbor—is somewhat difficult to grasp. Indicative of its magnitude, Boston called for 400 volunteer firemen, found 1200 on hand for the first drill; New York City has graduated 20,000 volunteer "smoke-eaters" from an intensive 15-week course; Chicago's police force is recruiting 7000 members from 224 American Legion Posts to be trained as emergency police; more than a million Legionnaires have just been assigned by President Roosevelt the job of organizing and conducting—mostly at the Legion's expense—"schools for the training of personnel for the protective services in the Citizens' Defense Corps of Civilian Defense;" due to the unprecedented rush of men and women to acquire first-aid and other civilian medical information and training, the first-aid text book of the American Red Cross has been at a premium in many communities for weeks.

Where will all this lead us? What will be the effect on a nation of people who, equipped with knowledge gained the hard way—and it isn't easy, after the day's work is done, to devote four to ten hours a week to schooling—will know exactly what emergency treatment to apply in case of a highway accident? Will it not be constructive for thousands of industrial workers, as well as men and women in all branches of industry and civil life, to be familiar with the technique of resuscitation in accidents involving electrical shock, inhalation of gas, drowning, and so on? Can we not hope to become a nation of better automobile drivers, from the dual standpoints of safety and economy, if we understand more of the "whys" and "wherefors" of the "innards" of our cars? What of the benefits to be derived from a broader and more intimate knowledge of foods and their nutritive values, of general health and sanitation, of waste prevention and salvage?

The cumulative answer to these and similar questions—despite the long, hard road of war and its destructiveness and sacrifice—is the unqualified statement that we *shall* be a better nation, a vastly improved people. Still in hearty accord with General Sherman, we contend that the constructive forces at work today, on a hitherto unheard-of magnitude, will be productive of wide-spread benefit and welfare. As the war progresses, we shall learn—if we have not already found out—that the job of protecting our ways of life from totalitarian encroachment cannot be done with one hand while the other retains a golf club, a tennis racquet, a fishing rod, or a highball—and that doesn't mean we must deny ourselves recreation. To the contrary, now, more than ever, we need recreation to offset the additional stress of personal war efforts. But it does mean that we're faced with a two-fisted job that must be done in typical two-fisted American manner; that each individual, efficiently to perform his share, must make of himself a better executive for the accomplishment of his normal business, social, and recreative life, as well as his extra-curricular defense activities.

There can be no doubt but that the forces emanating from efforts of civilians to fit themselves into a nation and a world at war have constructive characteristics. There can be no doubt but that the concurrent attempts of fifty million or more men, women, and youngsters to find the answer to their question, "How can I help?" will, at first, produce a certain amount of chaos, many uncomfortable growing pains. But, as stated in these columns before, it is an absolute certainty that the people of this democracy are organizing, are building, and will maintain the greatest civilian war effort ever known—and they're being amazingly constructive about it.—*A. D. R., IV.*

FOR THE RECORD

SEVERE criticism has been leveled, in some quarters, against certain publications for the printing of information and illustrations that, allegedly, may have been of some value to the enemy. As to the truth of this claim insofar as it applies to each and every individual magazine and newspaper in the country, we are not in a position to speak with authority, but we question whether any reputable publication has knowingly violated the code of honor voluntarily assumed by most editorial desks long before hostile action against the United States.

So far as Scientific American is concerned, no illustrations or text pertaining to our national defense efforts prior to Pearl Harbor, or to our war activities since that date, have appeared within our pages which have not received the approval of the proper officials of the Army, the Navy, or the Marine Corps.—*O. D. M.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of April, 1892)

LOCOMOTIVE—"The Brooks Locomotive Works, of Dunkirk, N. Y., have recently furnished the Great Northern Railway with fifteen of the heaviest locomotives in use in this country. The general appearance of these engines may be seen by reference to the accompanying illustration. The cylinders of the first ten of these engines are 20 by 24 in., five of the ten having wagon top and five Belpaire boilers. The other five have Belpaire boilers and cylinders 20 by 26 in., which is the engine shown in our illustration. . . . This locomotive will haul,

in addition to its own and the weight of the tender, the tracks being in good condition and comparatively free from curves: On a level—4,505 tons of 2,000 lbs.; on a 20 ft. grade—2,010 tons of 2,000 lbs.; on a 100 ft. grade—578 tons of 2,000 lbs."

STREETCAR—"The Woodland Avenue and West Side Street Railroad Company, of Cleveland, O., has been testing a new storage battery car, with the view of equipping its lines with the same should the test prove successful. The car measures 21 ft. inside over all and is equipped with 180 cells, which are placed under the seats, serving to operate a forty horse power Ford & Washburn motor."

INVENTORS—"The larger the number of patents granted, the greater will be the number of new industries established, and our measure of prosperity correspondingly increased. As a people we have everything to gain and nothing to lose by encouraging inventors, no matter where they live or where they were born."

PECCARIES—"A recent publication of the National Museum contains a paper, by Mr. Frederic A. Lucas, on animals recently extinct or threatened with extermination. He finds that in nearly every instance the cause is 'reckless slaughter by man.' As an instance of the way in which animals may be destroyed, he refers in the introduction to peccaries. In 1885 these little animals were so abundant in several counties of Texas that their well-worn trails were everywhere to be seen, while their favorite haunts could be readily picked out by the peculiar musky odor characteristic of the creatures. Shortly after that date, hogskin goods being in favor, a price of fifty cents each was offered for peccary hides, with the result that by 1890 the peccaries were practically exterminated."

OIL BURNERS—"The competition between oil fuel and coal is a most interesting one, and certainly shows an increasing use of oil where the conditions are favorable for its employment. Perhaps the most conspicuous of the advantages possessed by oil over coal as a fuel is the readiness with which the most intense heat can be employed at any special point desired, and the economy with which it can be used for just the period required. In addition, there is a great saving of labor in the use of oil, and, as there are no ashes, all the work around the boilers and furnaces can be kept in a much more cleanly condition."

CAVE DWELLERS—"The Russians have made a singular discovery in Central Asia. In Turkestan, on the right bank of the Amon Daira, in a chain of rocky hills near the Bokharan town of Karki, are a number of large caves, which, upon examination, were found to lead to an underground city, built, apparently, long before the Christian era. According to the effigies, inscriptions, and designs upon the gold and silver money unearthed from among the ruins, the existence of the town dates back to some two centuries before the birth of Christ. The edifices contain all kinds of domestic utensils, pots, urns, vases, and so forth. The high degree of civilization attained by the inhabitants of the city is shown by the fact that they built in several stories, by the symmetry of the streets and squares, and by the beauty of the baked clay and metal utensils, and of the ornaments and coins which have been found."

SPRINKLERS—"The introduction of automatic sprinklers has reduced the average loss per fire, within the experience of the Boston Manufacturers' Mutual Fire Insurance Company, where they were in service, to 8.3 per cent, and the average loss per claim to 6.9 per cent of what it is apparent that such fires and claims might have been under the previous conditions of protective apparatus."

GRIPPE—"There is much truth in the remark of one who observed: 'The worst thing about the grippe is that you are sick with it so long after you get well.' "

RAIL SPEED—"Engine No. 385 of the Central Railroad of New Jersey broke all records of high speed on February 26, by running a mile in 39¼ seconds, or at the rate of 91.7 miles per hour. The engine is a Baldwin compound. In speeding this engine the first mile was made in 76 seconds, the second in 62, the third in 53½, the fourth in 45½, and the fifth in 39¼ seconds."

PHOTO-ENGRAVING—"The first 'process' pictures, as photo-engravings were called, were very faulty, principally from the low relief obtained, which made them especially difficult to print in ordinary type forms, but by years of experiment and hard work this method of making pictures has been brought to such a degree of perfection as to practically supersede the more laborious hand engraving for quite a number of purposes."

MILITARY OBSERVATION—"The presence of balloons over the forts and encampments in Poland is becoming more frequent than ever, and this fact is causing much indignation among Russian army officers, who are helpless to prevent military secrets from becoming known to the German officers, who are known to be taking observations from a height that places them beyond the reach of any bullets aimed at them . . . Even modern cannon . . . could not be used against balloons, for the reason that gun carriages have not yet been made that allow of a perpendicular elevation."

"GUNS" OF INDUSTRY POINT SKYWARD

In the manufacture of Koroseal, synthetic elastic material of many uses, made from plasticized polyvinyl chloride, a huge solvent recovery plant is needed. In relief against the sky, the towers of the Goodrich recovery unit present a striking appearance in the photograph above. The largest of the towers, at the right, is 10 feet in diameter and 78 feet high. The center one is $6\frac{1}{2}$ feet by 68 feet, while the smallest is $2\frac{1}{2}$ feet by 54 feet. All of the towers were received on the site completely assembled and were erected in one piece.

98TH YEAR SCIENTIFIC AMERICAN APRIL 1942

GASOLINE MIRACLES

Higher Octane Aviation Fuels, But Not for Hitler

SIDNEY J. FRENCH
Professor of Chemistry, Colgate University

SCIENTIFIC RESEARCH

At this moment gasoline is the most important commodity in all the warring world. It will win and lose the war. This does not mean just any gasoline; it means high-octane gasoline. It means the type of gasoline that Germany, for all of her much vaunted *Luftwaffe*, would give almost anything—except Hitler—to possess. It means the type of gasoline which is peculiarly an American product, which packs the eventual knock-out wallop for Hitler and his Axis partners.

Just what is this high-octane fuel and why is it peculiarly an American product? It is American because America has produced more automobiles than all the rest of the world combined. It is American because America produces 60 percent of all the petroleum used in the world. It is American because better motors kept demanding better gasoline. It is American because 25 years of intensive search and research, trial and error, comedy and tragedy, have gone into the job of producing a fuel to meet the perfectionist demands of motor makers.

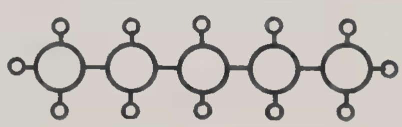
With what success? With such success that even the experts would not have dared predict, 25, or ten, or even five years ago. With such success that motor makers are now striving to catch up with the perfection of available fuels.

High-octane fuel is tailor-made gasoline, made to order from the crude materials provided by nature—made by cutting, patching, and sewing the very molecules of nature's product into new designs. It is one of the most remarkable stories of modern science, of sheer brilliance, in the American chemical industry.

Petroleum, source of gasoline, is nature's cocktail, a grand mixture of chemical compounds known to the chemist as hydrocarbons. In a spoonful of petroleum there are, literally, thousands of these compounds—and each one is composed of billions upon billions of tiny, identical molecules. In some respects all these invisible molecules are alike—they all consist of carbon and hydrogen atoms and, furthermore, nearly all of them have their carbon atoms strung together like cranberries on a Christmas chain. Decorating each "cranberry" are "glass-headed pins" representing the hydrogen atoms. It is principally in the *number* of cranberries that make up the chain that these various hydrocarbons differ. There may be anywhere from one to 30 berries, with the number of hydrogen pins always twice the number of berries plus two.

To distinguish one of these chain compounds from another, the chemist adopts a simple expedient; he counts (in Latin) and adds the ending *-ane*. Thus, a chain of five carbon atoms is pentane; of six, hexane; of seven, heptane; of eight, octane, and so on. Unfortunately, however, the counting scheme was not started soon enough and those hydrocarbons having less than five carbon atoms still bear names unrelated to numbers: one carbon atom, methane; two, ethane; three, propane; four, butane.

Here, then, is our cranberry-pin model of pentane, with its five-carbon-atom cranberries linked together and its five-times-two-plus-two hydrogen-atom-pins stuck into the berries:



The gasoline family includes those hydrocarbons which have anywhere from five to nine cranberries in the string, plus many more deformed relatives. Starting with a petroleum cocktail, how do we get these particular strings separated from the rest?

The answer is simple: The shorter the chain, the lower the boiling point of the hydrocarbon. Heat petroleum and the gasoline fraction boils off first. Next, as the boiling point of the mixture rises, comes off the kerosene fraction consisting of longer chains; followed in turn by the light lubricating oils, the heavy oils, the greases, and finally, paraffin. In this process of distillation some 20 percent of the original petroleum mixture is obtained as gasoline.

In the days when Henry Ford's Model T was beginning to make history, the small amount of gasoline obtained in this manner was sufficient. So was the quality. But the time soon arrived when neither the quantity nor the quality sufficed.

Gasoline is an explosive; that is what makes it function in an automobile cylinder. But what a difference there can be in explosives. No date-conscious person would take a swift kick at an old hat lying in his path on April the First. Instead, he would shove it gingerly, and then steadily, with his toe, and thus remove the hidden brick from his path without repercussions to the toe. This is the type of gasoline we need in modern motors—the type which pushes, not kicks; the type which explodes gradually, not suddenly. As long as we stuck to the Model T car, it didn't make much difference what we used, but when motor makers began increasing the compression in their motors in order to get a more efficient engine, the fuel began to kick.

Gasoline makers were placed squarely behind the eight-ball. How could they produce a fuel that would not knock, yet at the same time how could they increase the quantity of fuel needed by a nation rapidly taking to wheels? Surprisingly enough, they did both jobs with one stroke of the knife: They cut up long molecules into shorter ones.

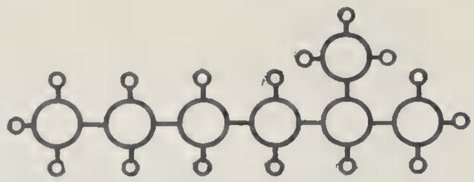
Suppose we were to cut a chain consisting, say, of 14 cranberries and the accompanying 30 pins; and suppose that we could cut it exactly in the middle. We would have two chains of heptane. Not quite, because there wouldn't be quite enough hydrogen to go around. Thus, out of one molecule of light oil we have produced two of gasoline. How was this done in practice? By heating the petroleum under pressure—in technical language, thermal cracking. This was the ingenious scheme that was developed as early as 1915 to increase the yield of gasoline. But it did far more; it greatly increased the anti-knock quality of the fuel. The very fact that there was not quite enough hydrogen to go around left these heptane molecules in what the chemist calls an unsaturated state, and these unsaturated molecules are better fuels than their saturated brethren. In one relatively simple operation both the quantity and quality of gasoline were greatly improved.

But there was one catch in the operation—the molecules did not always break in the right place; some of the molecules were too short to be useful in gasoline, others were too long.

Even this great improvement could not satisfy for long. Motor makers began stepping up the compression still more, and the gasoline makers found themselves behind the parade again. They began putting everything they could think of—except water—into the gasoline, in the hope of finding something which would silence the disturbing knock. Finally, they found the answer in that surprising substance, tetraethyl lead. Affectionately dubbed Ethyl, this compound, present in but trifling amounts, performs the miracle of retarding the explosion of gasoline—and increasing the horsepower of the motor. Just how and why it performs this miracle scientists are still trying to find out.

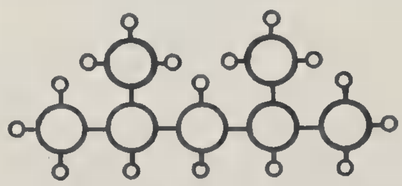
This great advance came in the 20's but it took the 30's to show the gasoline technologist just what he must do to make tailor-made gasoline. He had the goods, the raw materials, but he must cut them up, sew them, patch them, fit them to a form. It turned out to be a matter of just how the cranberries were arranged in the strings.

Given seven cranberries and 16 pins, how many different chain and cross-chain patterns can be made? The answer is, a dozen or more. We need consider only four in addition to the simple straight chain pattern. First, let us remove a cranberry from one end and place it on the side, thus:



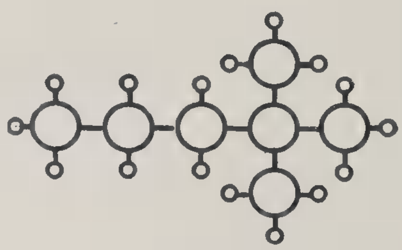
This is one of the numerous iso-heptanes. The surprising fact is, however, that this particular heptane has much better anti-knock qualities than its straight chain brother.

Now let us remove a cranberry from the other end and place it on the side; we have another iso-heptane, thus:



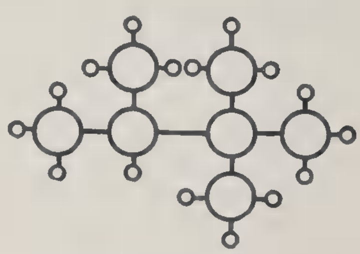
Once more the anti-knock qualities go up the scale.

Next, we arrange these side chains so that they are opposite one another, thus:



Up go the anti-knock qualities again.

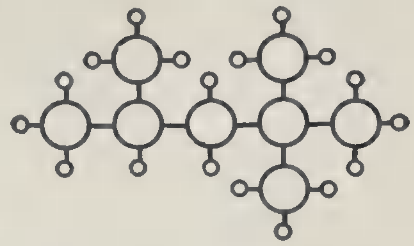
Finally, we remove another berry and place it on the side. We have the iso-heptane known as triptane:



This is the best anti-knock fuel yet discovered by man.

Here, then, is the secret of anti-knock fuel. Take a straight chain hydrocarbon of the gasoline family, pull off carbon atoms and sew them on the sides like sleeves in a coat. Tailor the goods. Much easier said than done, however.

A few years ago the fine anti-knock qualities of iso-octane were discovered. Iso-octane, like triptane, is a branched chain affair of the following pattern:



Since it was the best anti-knock gasoline then known, it was appropriately assigned an *octane number* of 100. At the other end of the octane scale was straight chain heptane, a highly audible knocker, with an octane number of zero. To determine its octane number, any given gasoline could be compared, in performance, with various mixtures of the two standards.

On this octane scale, old-fashioned gasoline used by the early Model T had an octane number of 40 to 60; thermally cracked gasoline, 70. With tetraethyl lead, the number could be boosted to about 80. Had we discovered triptane before iso-octane we would most certainly have had a scale in heptane instead of octane numbers, because this particular iso-heptane cannot even be placed on the octane scale. It is somewhere above 100. Actually it delivers about 50 percent more power than 100 octane fuel.

Why not use triptane for aviation fuel? Largely because aviation has been geared to 100 octane fuel and in time of emergency we dare not take the time to make the necessary change in motor design. Then, too, triptane, worth $3600 a gallon just a few years ago and still worth nearly $40 a gallon, is just a little expensive, even for war. It is safe to predict, however, that this tailor-made super-fuel will soon be available at prices low enough for use by Uncle Sam's air force—if we can find the time to make the change-over in motor design.

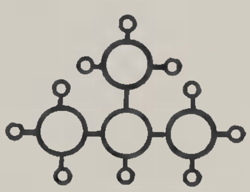
Yes, not too many years ago the gasoline makers were behind the eight-ball, but not today. They are ahead of the parade and calling to the motor makers to catch up. How did they do it? It is an easy matter to rearrange cranberries, but it is not so simple to rearrange atoms in invisible molecules.

The chemists have some strange chemicals which they call catalysts. Like traffic police, these chemicals can direct chemical traffic without themselves becoming too involved in the streams. They stand apart and somehow get other molecules into the right lanes—get them united or separated as

the particular case in hand demands.

It is these remarkable traffic police which have come to the aid of the gasoline technologist. First, the gasoline molecules are cracked into smaller bits by a modification of the old thermal cracking process. Then the catalysts take over and see to it that the fragments are reunited in the proper arrangement to give the branched chain hydrocarbons. True, there is always some mix-up in the traffic; some molecules never get cracked; some fragments never get united. But the vast majority go through as planned and the octane number goes up. If greater perfection is desired—if higher octane numbers are wanted—this, too, can be accomplished by the absurdly simple scheme of making the molecules go through the traffic lanes a second time. Many that were not caught on the first passage are properly apprehended and redesigned in the second attempt. To make automobile fuel, they go through once; to make aviation fuel, they go through twice. It is as simple as that!

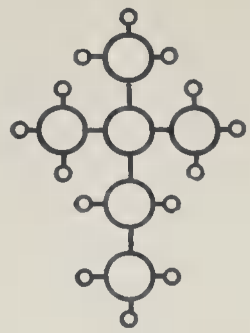
PERHAPS the most interesting of the very recent catalytic processes is that known as alkylation, coupled with another known as isomerization. Isomerization merely means the making of a branched chain molecule out of a straight chain brother of the same denomination. In the older thermal cracking process, some butane (four carbon chain) was produced and, since it was too short of chain to be useful as gasoline, it was often wasted. Now it finds a new and strategic use. It is redesigned with the aid of a catalyst into iso-butane, thus:



In this same cracking process the unsaturated brother of ethane (two carbon chain) was also produced, thus:

Notice that these cranberries are linked together with *two* threads.

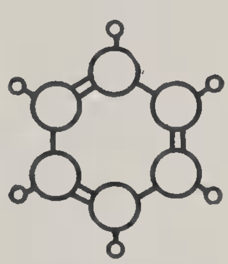
Now, presto, the traffic catalyst takes command; the iso-butane and the unsaturated brother of ethane are directed into the same channel and are ordered to unite. Out comes a molecule of iso-hexane with an octane number of 96, like this:



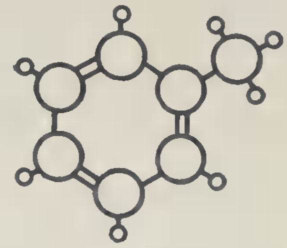
This is the type of reaction which is of great importance in the production of Uncle Sam's modern aviation fuel. Add a dash of tetraethyl lead and we get 100 octane fuel.

Octane numbers are very deceptive; they do not mean what they say because the power goes up much faster than the numbers. Triptane, with a power output of 50 percent more than 100 octane fuel, would actually have an octane number of about 110. The best that Hitler can get today is 87 octane fuel and this is 30 percent less efficient than 100 octane variety. This means that Hitler's planes must be content with less speed, lower ceilings, smaller cruising ranges, longer times for climbing to a given altitude, and more wear and tear on the motors—all to the tune of some 30 percent less in efficiency. What could we do if we could utilize our now available 110 octane fuel which should give us some 80 percent more effective power than Hitler can now get?

THERE is still another side to this amazing story of tailor-made products from gasoline. In World War I we heard much about Germany's stranglehold on coal-tar chemicals—dyes, drugs, and explosives—and we suffered much because we had naïvely depended on Germany to provide them for us. These coal-tar products are all based on hydrocarbons—but of quite a different type from those found in gasoline. Instead of being in a string, the cranberries are found in rings, six to a ring. And for each cranberry in the ring there is only one hydrogen pin, thus:



Note that the compound is unsaturated. It is our model of benzene, with its famous hexagon. To get others of these circular hydrocarbons, we may remove one or more pins and substitute decorated cranberries. Thus, we may have:



This is our model of toluene, famous as the basis of TNT, most important of modern high explosives.

A FEW years ago cyclic hydrocarbons of this type could be obtained only from coal tar. Now we can make them from gasoline. So desperate were we for toluene during World War I that city coal gas plants were stripped of their toluene. Today, in the brand-new hydroforming process, gasoline molecules are catalytically denuded of half of their hydrogen atoms, then are directed by the catalyst to curl up and tie their ends together. Presto! From straight chain heptane we get circular toluene.

So, today we can make our explosives—and even drugs and dyes, if necessary—directly from gasoline. We need no longer fear a shortage of toluene. Strange thing: in Hitler's country, with its paucity of petroleum, they are making gasoline from coal; in America, we reverse the process and make coal-tar products from gasoline. And incidentally, this same toluene is an excellent anti-knock fuel for motors, having an octane number above 100.

Gasoline can provide the premium fuel for our planes and the bombs to drop from them—what else can it do? It can—and probably will have to—provide the rubber for the tires. Gasoline provide rubber! Yes, strange as it may seem. The basic molecule from which rubber is formed is an unsaturated brother of butane. The chemist calls it butadiene. Here is the model:

Just as hydrogen can be stripped from heptane to make toluene, so, too, it can be stripped from butane to make butadiene. Again a catalyst is put to work directing a side chain onto this butadiene molecule. Then, much as isohexane is made, these fundamental units are tied together into long, folded strings of synthetic rubber. Given time, we can make all our rubber from gasoline and other simple substances. True, it may be a more costly process than draining a rubber tree, but the impor-

tant thing is that we now know how to do it.

There are many things yet to come from nature's cocktail. What they will be is hard to imagine as yet, but we have taken the most difficult step; we have learned how to re-design the molecules. We will live to regret the years in which we have wasted precious petroleum, wasted it as a child might tear up a rare volume to get one picture. In the future we will conserve it: we will treat it as we are learning finally to treat our forests, minerals, and our other God-given wealth of natural resources. We stand today where Germany stood in 1914—master of the most important commodity of modern war. Then, it was coal tar; now, it is gasoline—tailor-made gasoline.

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PYRHELIOMETER

New Instrument Measures Heat of Sun's Rays

PRINCIPAL use for a new type of pyrheliometer for measuring the heat intensity of solar rays that reach the earth is for atmospheric study, yet other potential applications present themselves.

A florist might logically install a pyrheliometer in his greenhouse to determine the intensity of the sun's rays that penetrate the glass roof at various times. Agricultural experiment stations also might find a use for the device in their studies of crops and soils. The intensity of the infra-red ray used for drying paints and for similar operations also might be measured. In fact, the instrument could be applied to the intensity measurement of radiated heat of long wavelength irrespective of the visibility of that wave.

The pyrheliometer, a type of thermocouple, looks somewhat like an electric light bulb. The "filament" comprises two flat, rectangular pieces of a nickel-chromium alloy and a copper-nickel alloy, each only 50 millionths of an inch thick, $\frac{3}{16}$ of an inch long, and $\frac{1}{64}$ of an inch wide, joined end to end. This thin single piece of metal is then welded at the outer ends to vertical lead posts that lead to a stem which is wired for hook-up to a millivoltmeter. The end of the stem to which the posts are attached then is sealed into an evacuated glass bulb which is a sphere about two inches in diameter.

The pyrheliometer is mounted vertically in a fixed position with the flat edges of the "filament," or element, parallel to the earth. The heat from the solar rays striking the element produces a voltage at the junction of the welded alloys. This voltage is measured by sensitive millivoltmeters and is automatically recorded on a chart. This record then can be compared with a master chart made from known heat intensities.

Thin alloy strips in an evacuated glass bulb measure sun-ray heat

• • •

EARTH RESISTIVITY: Recent attempts to correlate greatly differing electrical earth resistivities in different regions of the United States with the geological structure of the earth in the same region shows that the resistivity is usually lower in regions of recent geological origin. The resistivities vary from six ohms between the opposite faces of a cube one meter on a side in Oklahoma to 7000 similar "ohm-meters" in Maine and 10,000 in northern Georgia.—Bell Laboratories Record.

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ELEMENT 61

Appears Briefly Then Disintegrates

A FORM of element 61, believed to be the only element of the 92 in the chemist's periodic table not found in nature and never before produced artificially, made a brief appearance recently as a result of bombardment of other elements with atomic fragments whirled at them by the University of California's cyclotron.

The new substance stayed just long enough to show by its radioactivity that it was present and then disappeared completely by disintegration, according to *Science Service*.

The experiments were made by Dr. Emilio Segre, research associate in the Radiation Laboratory, and Dr. Chien Shiung-Wu, research fellow. The rare earths bombarded were sent to Dr. Segre a year ago by an Italian chemist, Dr. Luigi Rolla.

Element 61 belongs to the group of rare earths, of which there are 15. The atomic number 61 means that the nucleus or central core of its atom has a positive charge 61 times that on the nucleus of a hydrogen atom, and this is neutralized by 61 negative electrons revolving about it like planets around a central sun. Each chemical element has various forms, known as isotopes, and one of these of element 61 is believed to have been discovered.

From its position in the periodic table, scientists know that the atomic weight of element 61 should be about 148, and can predict fairly accurately its principal chemical and physical properties. But unless and until a fairly stable form is found, one that will at least stick around long enough to be measured, these predictions cannot be verified.

STEREOSCOPIC

Views Now Possible With Electron Microscope

THREE-DIMENSIONAL, or stereoscopic, pictures of infinitesimal bits from the submicroscopic world, are now possible by means of the electron microscope, it was announced recently by Dr. V. K. Zworykin and James Hillier, of RCA Laboratories, in presenting a joint paper at the annual meeting of the American Association for the Advancement of Science.

They revealed a new photographic technique, which adds depth to the length and breadth of images as they appear in the micrographs, as the photographs taken directly from the electron microscope are called. With this new method, the scientists reported, the electron miscroscope, which recently made it possible to photograph the influenza virus for the first time, becomes an even more powerful tool for use in pure science as well as industrial research.

The electron microscope is especially well suited to the preparation of three-dimensional pictures, Zworykin and Hillier said, because of its remarkable depth of focus. Two pictures of the object are taken in succession, the object in a special holder being tilted through a fixed small angle with respect to the instrument's axis, first in one direction and then in the opposite. When the two pictures so obtained are placed in an ordinary stereoscope, the object, greatly magnified, appears in its proper space relationship.

Testing with 'Lightning Bolts'

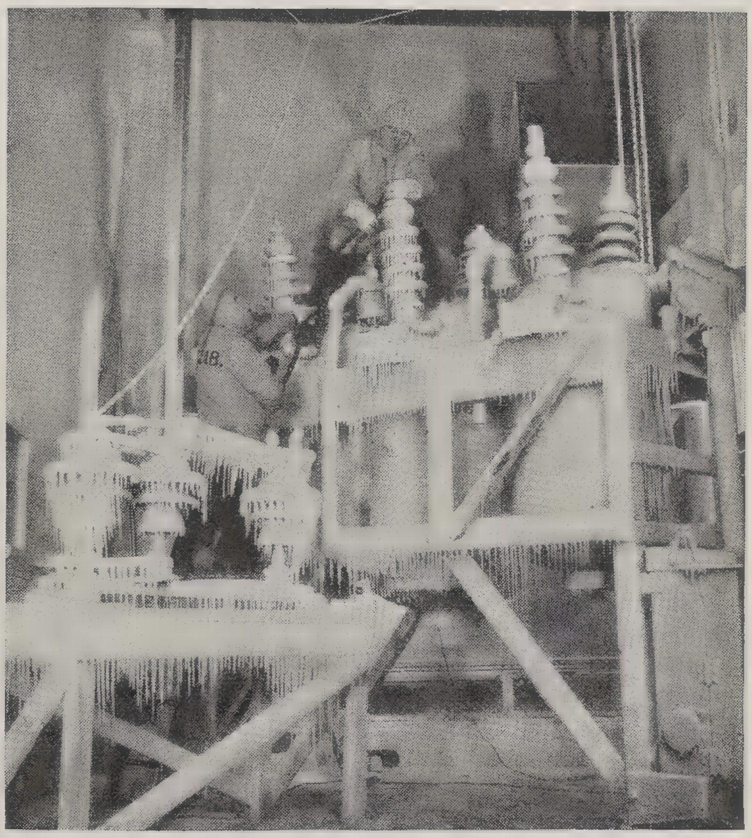
Mighty Generators Provide Two Million Kilowatts To Prove Efficiency of Power-Line Guardians

A. P. PECK

A SABOTEUR has gained entrance, by devious means, to a power station. Watching his chance, he slyly throws a metal bar across one of the main circuits. A blinding flash, as the power is short-circuited, and his work is done—if a circuit breaker fails to accomplish its designed purpose of standing constant guard over the line. Or a large bird, touching two wires of a power line, may accomplish the same end. Sleet and snow storms may break and ground line wires, and even rats crawling between conductors in a power house may cause short circuits. In all cases, however, circuit breakers of one sort or another are on the job to prevent the sudden surge of current, caused by the short circuits, from doing extensive damage.

But, in these days of increased power loads everywhere, brought about by the demands of defense industries, how can it be determined in advance that the circuit breakers will take the load, will cut off the power in the few seconds that spell the difference between protection and disaster? Since it is not practical to wait for such proof under operating conditions, or purposely to create short circuits in power lines in use, Westinghouse engineers have recently put into regular service a high-power testing laboratory where protective devices can be proved at powers in excess of those to which they might be subjected under the most severe field conditions.

The power source for the new testing laboratory is a twin 500-ton generator set capable of delivering test charges carrying twice as much power as is produced at any instant at Niagara Falls. Each of these two generators, the second of which was recently completed to make possible testing of the largest types of protective devices before they are put into service, is driven by a 6000-horsepower motor. They are designed to produce electric "knock-out punches" in excess of 2,000,000 kilowatts, the mechanical equivalent of which is over 2,680,000 horsepower. It has been estimated that if the generators could continuously deliver their combined output, they would supply sufficient energy to light enough tube-shaped fluorescent lamps to encircle the earth twice at the equator. The generators were designed, however, not for continuous service but for tests in which they deliver their energy over a time period of five seconds maximum. Thus they might be compared to a prize fighter who can pack terrific power into a knock-out punch but cannot deliver many such powerful blows in succession without resting. In the case of generators, the punch is produced electrically by short circuiting the output of the machines.



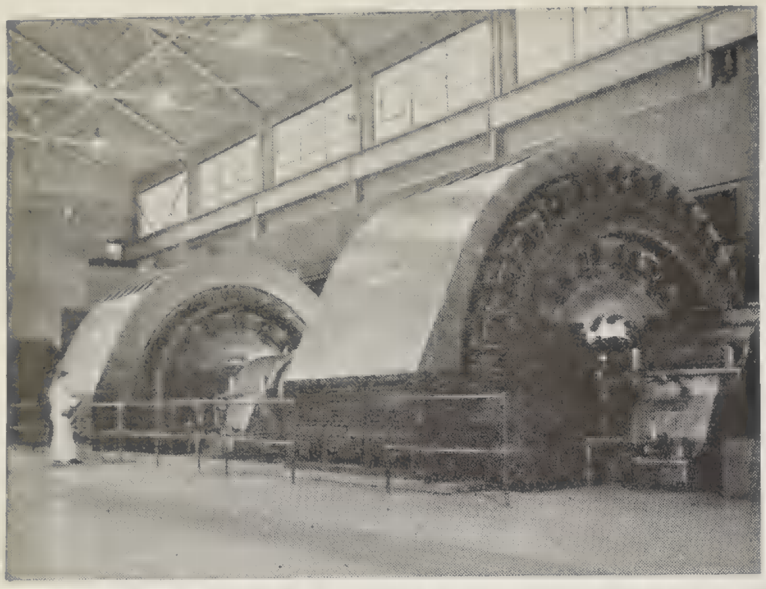
Man-made sleet storms test on oil circuit breaker

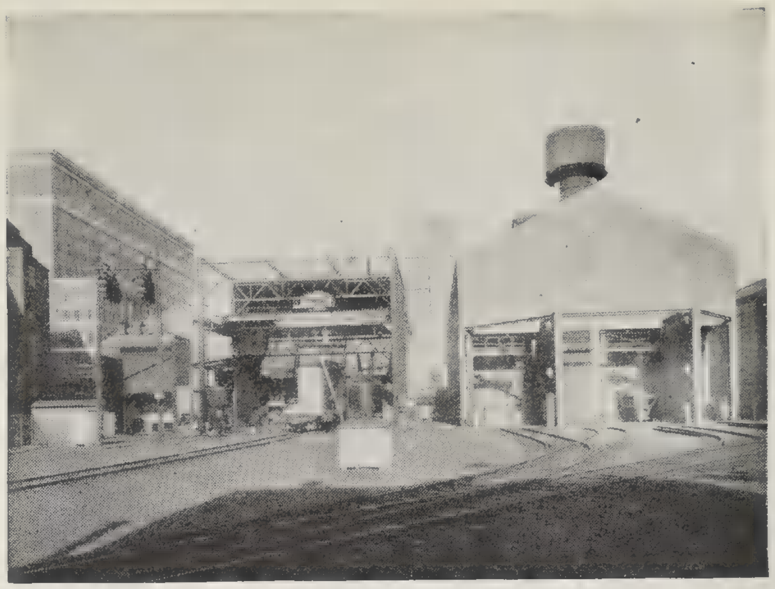
Spinning at their top speed of 514 revolutions a minute, the generators' two 300-ton rotors set up vibrations, when short circuited, that shake the very foundations of the laboratory building in which they are housed. When the energy is suddenly drained from the machines, the entire 1000-ton mass of the two units recoils like a gun. Special spring-steel mountings take up the shock to protect the reinforced concrete foundations.

The electric power output from the generators can be fed through a bank of transformers in an outdoor yard where the voltage can be raised to 396,000 volts for special tests on insulation. Other transformers can be cut into the circuit to increase the current to 345,000 amperes. Distribution of power from the generators is controlled from two switchboards in the power laboratory, each 20 feet tall and studded with knife-type switches made of copper bars about two inches wide and a quarter inch thick. Here, too, are switches which, a twentieth of a second after a signal from the control room, automatically snap shut under a pressure of 6000 pounds to release the power of the generators to the equipment to be tested.

For the protection of the high-power laboratory machinery, ten photo-electric cells are located at strategic points in the power house. If an arc should flash across the terminals of one of the switches or across the windings of one of the generators, the photo-cells would "see" the arc and set in motion the necessary mechanism to actuate switches that would disconnect the power before damage is done.

For use in connection with the test generators there has been set up a series of cells where equipment to be proved can be installed and tested. These cells, with one side open, are all visible from a control room where engineers supervise the testing activities through a system of loud speaking telephones. In this control room, also, is located an oscillograph which records the results of tests on photographic film. When a switch in the control room is closed, a row of notched rotating steel disks goes into action, synchronizing the release of power from the generators with the motion inside a circuit breaker being tested and with the recording instruments. A twentieth of a second after the notch of the first disk makes contact, the master switch in the power house closes automatically, releasing a "lightning bolt" into a circuit breaker, fuse, or other device under test. At





***Left:* Power twins that produce momentary torrents of 2,000,000 kilowatts. *Right:* Power house, other testing facilities**

the same time the oscillograph goes into action, recording by wavy gray lines the voltage and amperage of the electricity shot through the unit being tested, how quickly the device cut off the electricity, and, in a circuit breaker test, the pressure of oil or air which quenched the electric arc.

As noted earlier in this article, there are many ways in which a short circuit can occur on a high-power transmission line. If no protective devices were employed, such a short circuit would start a flood of power through the electrical system 20 to 30 times as great as the system was designed to carry. If not checked, this abnormal power would heat up wires, generators, and motors, burning off insulation in less than a minute and creating damage that it might take years to repair.

Such disasters are normally prevented by the use of circuit breakers of various types which stand guard on every power line and every branch of every line. Simplest of circuit breakers are fuses such as used in the home. When a short circuit occurs in a fuse-protected line, the fuse link burns out, disconnecting the defective part of the system until the short circuit is removed, yet allowing the remainder of the system to continue in operation without danger. Such fuses, although used on occasion even in high-power lines, require manual replacement before the defective circuit can be put back into service. Thus it is that circuit breakers are frequently employed to halt the flow of electricity into a short-circuited section of a power system until the damage can be repaired. According to engineers familiar with high-power circuit operation, a majority of short circuits—such as those caused by lightning, animals, and wind—last only for a fraction of a second. In such a case the circuit breaker opens for a short space of time and then automatically reconnects the line so quickly that the power interruption is scarcely noticed. Some circuit breakers are designed to re-establish the connection once and then, if the trouble has not disappeared, to open and remain open until manually closed; others will reconnect two or even three times before remaining open.

But the job of a circuit breaker is not finished when its contacts open. In high-power operation, an electric arc is formed in the gap between the device's opened contacts. As long as this arc continues, the power line is not completely disconnected and the destructive high power of the short circuit can continue to spread to all parts of the system. To accomplish the feat of extinguishing this arc, two general systems are employed. In one of them, the mechanism of the breaker is immersed in oil contained in a steel tank. As the contact breaker opens, under the influence of a short circuit, the arc is drawn into a chamber containing metal plates. Magnetic action set up by these plates forces the arc into constricted sections where it is smothered by the oil. In the most modern of the protective devices, compressed air is used to blow out short-circuit arcs. In less than a hundredth of a second a compressed-air circuit breaker can cool an arc from a temperature of 9000 degrees to 200 degrees, snuffing it much as a puff of breath blows out a candle.

In these compressed-air circuit breakers, a small relay is provided which instantly detects a short circuit and sets in motion the mechanism of the breaker. The relay opens a valve and releases compressed air against the top of a piston which spreads the breaker's contacts apart. This action also operates another valve, releasing a 150-pound blast of air which forces the arc into a fan-shaped chamber where the air pressure breaks the arc into short sections and annihilates it.

In a recent demonstration of the Westinghouse high-power testing laboratory it was shown how the output of the 2,000,000-kilowatt generators is used to test these line protective devices. To indicate vividly the amount of power employed in these tests, the laboratory generators were connected to two curved pieces of heavy wire extending upward from a fuse link. When the power was shot into the link, the fuse instantly let go, starting an arc which traveled upward between the two wires of the gap, eventually leaping the upper end of the gap in a 20-foot waving, flaming, thundering arc as bright as the mid-day sun and hot enough instantly to melt the hardest steel.

Continuing the demonstration, the same amount of power was then fed into an oil circuit breaker located in one of the test cells. Within a twentieth of a second after the release of the 2,000,000-kilowatt surge of electricity—simulating conditions more conducive to disaster than would prevail during the short circuiting of the highest power transmission line in existence—the circuit breaker emitted a mechanical grunt, blotting out the flood of power quicker than the blink of an eye.

In another test it was shown how a compressed-air circuit breaker blew out the high-power arc. To illustrate the magnetic forces in the cables carrying the charge in different tests, the inch-thick copper cables were sandwiched between six-inch timbers, which were bound with half-inch rope. The surge of power set up magnetic forces which thrust the cable apart with such violence that the rope was snapped like twine and the timbers split into kindling.

Another phase of power line protecting test work which is being accomplished at this new laboratory is

the checking of equipment operation at low temperatures. A room-sized refrigerator has been installed as a part of the laboratory, where temperatures of 20 degrees below zero can be produced. In this refrigerator can be set up various types of switches, insulators, and so on, to be tested with the high power under varying conditions of cold. During the recent demonstration, the temperature of the room had been reduced to a point where a power switch, mounted on porcelain insulators, was covered with a thick coating of ice. When current, at a pressure of 60,000 volts, was fed through the switch, a corona discharge formed around the porcelain insulator separating the switch contacts from the steel base. As the voltage was raised gradually, the corona increased in brightness until, at 120,000 volts, a crack of thunder filled the room and a brilliant arc jumped from the switch contacts to the steel base.

"Such tests as this tell how well insulated these switches must be when encrusted with ice," explained one of the engineers in charge of the work. "Since ice reduces the insulating quality of porcelain, the insulators on these winter-proof switches must be made tall enough so that electricity will not arc, or jump, from contacts to base when the line carries its normal voltage."

Thus, test torrents of electricity, created in the mightiest laboratory of its kind, make it possible to avoid interruption of the flow of vital power in the transmission lines of the nation, by making doubly sure that protective devices can cope with even the worst troubles that might arise.

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Recap to Keep 'em Rolling

Old Tires and Retreading Play Important Roles in America's Wartime Transportation Picture

JULIAN J. WILSON

UNLESS his automobile, truck or motorcycle is used directly in war production, or in activities deemed essential to the national welfare, the American car owner cannot buy a new tire for some time to come. Conceivably, this might not be possible until complete victory is achieved over Japan and her Axis partners. And, so far, no responsible official has stepped forward to predict that this is going to be a short war.

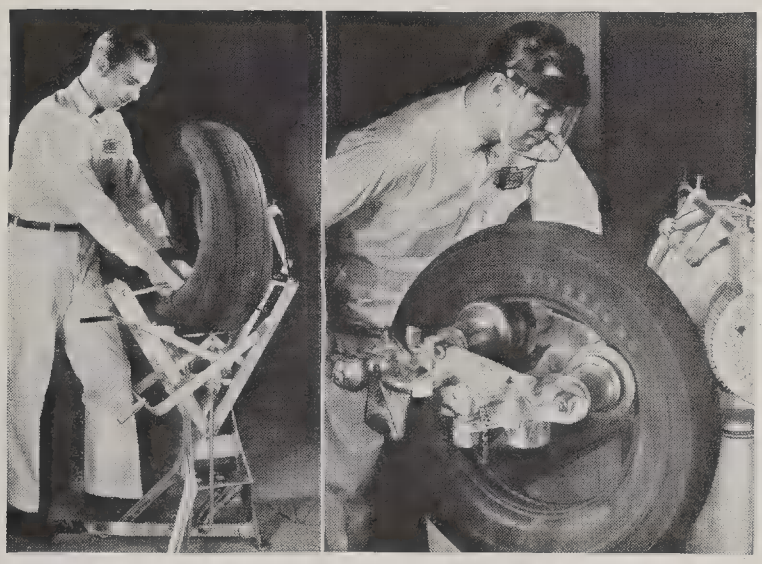
Just how much tire rationing may disrupt our national life is hard to say. For a people who have centered so much of their industrial and recreational habits around the easy transportation facilities of the automobile, the rubber shortage will not be painless. Realizing this fact, the motorist has been asking the gasoline station attendant and the garage mechanic one question:

"How can I get more miles out of my present tires?"

The answers to this question are brief and simple, according to development engineers of the rubber companies. They say emphatically that there are two things the motorist can and must do to get the maximum mileage life from his tires. First, he will have to eliminate those practices which *waste* the miles of service that are now available in his tires. Secondly, when present tires have delivered all of the safe mileage of which they are potentially capable, the car owner should have these tires retreaded, if possible, thereby insuring many additional thousands of miles of safe dependable service.

Taxicab owners, trucking fleet operators, and others have long recognized the economy of the extra tire mileage made possible by retreading. Instead of discarding a tire when tread wear has approached the danger point, these operators have had it retreaded for less than the cost of a new tire. Records show that one taxicab operator has had sets of tires retreaded as many as five times, and these tires are still in use after delivering over 100,000 miles.

It must be pointed out, however, that no tire can be retreaded indefinitely. Regardless of tread condition, a tire is only as good as its cord body. It is considered practical to retread a tire a second or third time, if the cord body and sidewalls of the tire remain in good condition. But if the cord body has been damaged or weakened to the point where it will not stand up for the additional miles which a retread is capable of giving, it is a waste of rubber to retread it the first time.



***Left:* Examination determines condition of cord body. *Right:* Rasp smooths uneven parts to a uniform surface**

IN a bulletin to the rubber industry establishing maximum prices for retreading, put into effect January 19th, the Office of Price Administration has given technical definitions of the terms used throughout the retreading industry, to clarify the rulings of that department. These definitions are as follows:

"Retreading means the process of reconditioning a tire by removing all the original tread rubber from the worn tire down to the fabric and applying new rubber to the tread surface and sidewalls;

"Recapping means the process of applying a top cap or full cap to a used rubber tire;

"Top cap means a tread renewal where the worn tread of the tire is buffed off the top surface of the tire and new rubber is applied to the tread surface only;

"Full cap means a tread renewal where, in addition to buffing off the worn tread, the shoulders of the tire also are buffed below the shoulder design and new rubber is applied to both the tread surface and tire shoulders;

"Camelback means the uncured rubber compound applied to the worn tire to make the new tread in the process of retreading."

The retreading or full capping of passenger car tires, as defined above, however, was made impossible by an OPM order effective January 12, which stopped all production of camelback of the sizes used for "retreading" or "full capping" of passenger car tires. On

February 19 an order went into effect rationing the camelback material for all purposes.

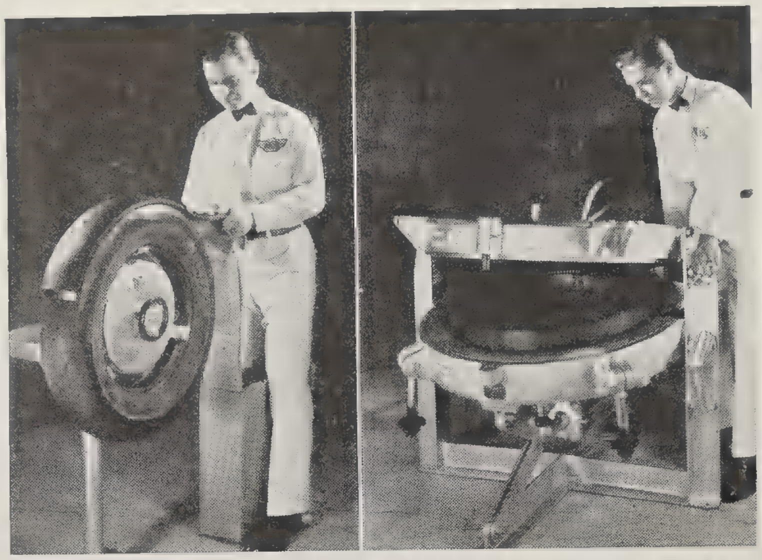
These rulings, made because of the necessity of conserving every possible ounce of rubber for wartime purposes, may, in reality, help the motorist to get more mileage from his tires. Before the rubber shortage it was the practice of many drivers to overwork their tires and to disregard simple rules for getting the greatest possible mileage from the original rubber. Too frequently, tires were run past the danger point, where the tread rubber was almost completely worn off, leaving parts of the cord fabric exposed to wear. As a result, many tires which could have been top capped a relatively few miles earlier, have had to be discarded. Longest mileage at lowest cost per mile can be obtained if the tire is top treaded when 20 percent to 25 percent of the normal tread life of the tire remains. This means a covering of $\frac{1}{16}$ inch to $\frac{1}{8}$ inch of tread rubber, which is sufficient to provide a solid foundation for the new tread rubber and, at the same time, protect the cord body.

Before a tire is accepted for top capping at a well operated retreading plant, it is first given a thorough examination by an experienced tire repairman. If the cord body shows cuts, breaks, or any other weakness which would tend to shorten the life of the tire after top capping, it is rejected. Rubber is too valuable to waste on weak tires. Only if the cord body is in condition to stand sufficient additional mileage will the tire be accepted.

The accepted tire is placed on a buffing machine which brings it into contact with a whirling rasp to buff the worn tread. This provides an even surface to which the camelback is applied. The camelback is then bonded to the surface with a special tire cement which holds it in place for further processing. Next, the tire is placed in the curing mold where the action of heat upon the camelback vulcanizes the tread and makes it an integral part of the original tire.

Those tires which are not accepted for retreading or recapping because of the weakened condition of the cord body, while useless in themselves, still are not a total waste. Through chemical processes, the rubber in these tires is separated from the cord body and the other materials that were used originally in making the tire. This reclaimed rubber can be mixed with new rubber in definite proportions and be used again for retreading.

The question most frequently asked is: "How will the mileage of a retreaded or recapped tire compare with that of a new tire?" No truly accurate answer can be given. That depends on the condition of the cord body of the tire, the methods under which it is retreaded, the quality of the camelback used, and the care it is given after it is returned to service.



Left: Tread stock, or camelback, is applied and, (right) vulcanized to bond to tire body and to form new tread

If only three or four of the most simple rules of tire maintenance and driving care are followed, American motorists can extend tire life by untold millions of miles.

YOUR TIRES WILL LAST LONGER IF YOU:

1. **Keep them properly inflated**
2. **Have a regular day for inflation**
3. **Drive at moderate speeds**
4. **Keep the wheels aligned**
5. **Start and stop gradually**
6. **Have cuts repaired immediately**
7. **Have experienced tiremen check them every month.**

Regardless of the effect of the War Production Board's order of February 19th on rationing of retreaded and recapped tires, this informative article will help all motorists

The two most prevalent causes of mileage waste are high speeds and incorrect inflation. A tire driven at an average speed of 50 miles an hour will deliver only 60 percent of the mileage it will return at 30 miles an hour. If the speed is stepped up to 60 miles an hour, only 45 percent of the potential mileage will be returned—55 percent wasted.

Incorrect inflation is just as wasteful as speed. Thirty pounds of air is the recommended air pressure for tires on many cars. If such a tire is operated at 27 pounds pressure, 21 percent of its potential mileage is wasted. A drop to 21 pounds pressure will result in a waste of 52 percent of its normal mileage life. The average tire loses three pounds of air a week, and should be inflated regularly to keep it to the recommended level.

Nor should over-inflation be practiced if the operator expects to get full mileage from his tires. Over-inflation reduces the amount of tread in contact with the road, induces slipping or spinning of the tire in stopping and starting. An over-inflated tire is also more susceptible to cuts and rim bruises.

Another thief of tire mileage is a wheel which is not in proper alignment. This shows up vividly in field tests. When two opposite wheels on an automobile do not run parallel to each other, one grips the road and runs in a straight line. The other is dragged sideways at an angle. A tire on a wheel which is only one-half inch out of alignment is dragged sideways 87 feet in every mile, causing excessive wear on one shoulder of the tire. Other mechanical faults, such as loose wheel bearings, worn bushings, loose steering connections, uneven brake action, bent axles, or any mechanical condition that impairs the straight, true running of the wheels will cost miles in terms of tire life.

There is a definite schedule of rotation of tires which, if followed every 5000 miles, will add extra miles. It is not necessary to remove the tires from the wheels in making this rotation. The procedure is first to move the front wheels to the rear positions on the same side. On the second move, shift the rear wheels diagonally to the front position. It is good policy to put the spare tire into use every alternate 5000 miles, as it is subject to deterioration if left unused for too long a time.

National surveys, made by The Firestone Tire & Rubber Company, show that the average motorist normally operates his car 20,000 miles on one set of new tires before replacing or retreading them. From records of field tests, where cars are operated under normal driving conditions, it has been definitely established that this figure can be raised safely to 30,000 miles, or even doubled, when proper precaution is taken in the care of the tires.

As a result of these extensive surveys there has been prepared a table of rec-

ommendations for the care of motor-car tires. If these recommendations, set forth on the preceding page of this article, are followed by American motor-car drivers, the result will be an enormous over-all increase in tire life.

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RECLAIMED

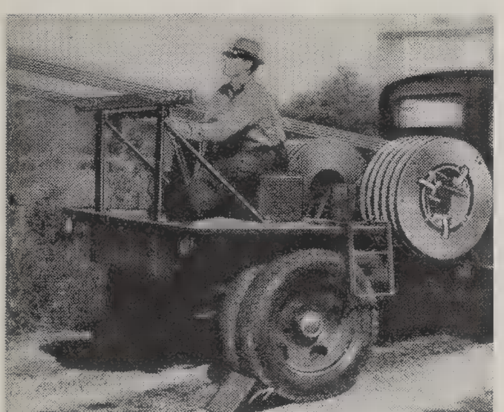
Metals From Mill Chips and Scale

EVERY pound of mill scale, chips, and grinding dust accumulated in the past year in the plant of a tool-steel producer has been carefully saved. Periodically, they are gathered and shipped to a refining plant 550 miles away. There thousands of dollars' worth of vital raw materials like tungsten, chromium, and vanadium have been salvaged and shipped back to the tool-steel maker to help conserve the nation's reserves of those strategic metals.

WIRE SALVAGE

Made Economical by New Winch

WIRE reclaiming winches and reels, produced by Gar Wood Industries, Inc., are now being used for fast and economical reclamation of telephone line wire. The winch saves in the cost of removal and also in the cost of maintenance since the wire removed is ready either for immediate re-use or to be sold to smaller companies for their requirements.



Ten miles of wire an hour

The wire reclaiming winch will reclaim all sizes of copper and iron telephone wire from poles. The winch will coil ten miles of wire in one hour and coil this wire in a form suitable for immediate use. When necessary to remove wire to put up new lines, it has heretofore been the custom to pull one short wire at a time on a collapsible reel. This was not only a slow process but also the wire was bent around the arms of the reel, making the wire useless except to sell as junk material. With the new winch, ten wires (each a mile long) can be coiled at the same time at a speed of 150 feet per minute; the reclaimed coils of wire are nearly as perfect as original factory coils of new wire.

IRON RESEARCH

Yields Method of Using Low-Grade Ore

A RESEARCH project on iron ore, which Henry Ford pushed steadily along for a dozen years despite meager results, now has opened additional possibilities in metallurgy and for automotive and defense manufacture. Experiments have produced a way to recover iron from vast deposits of unwanted, low-grade ore. But, even more significant, the iron obtained by the new method has some unusual characteristics that make it particularly useful in the new field of powder metallurgy.

Unlike ordinary iron recovered by smelting, the iron Ford has obtained is more ductile, it resists corrosion, and it has magnetic properties that improve motor-car performance.

Huge deposits of poor ore, much of it in Michigan's upper peninsula, were the original object of the Ford experiments. Smelting was ruled out as a method of iron recovery because of excessive cost. Research men tried a number of recovery methods and finally settled on electrolysis. The theory is not new, but Mr. Ford believes that an electrolytic method which would be feasible commercially has been perfected for special purposes.

The method of recovering iron from low-grade ore is really a system of electro-plating, and for work on an industrial basis, cheap electric power is essential. The system works this way: Iron is dissolved out of the ore in chemical solution, then is plated out of the solution by electrolysis. One electrode is coated with iron 99 percent or more pure, which can be removed in sheet form. Since the sheet contains a slight amount of hydrogen, it is easily pulverized for use in powder metallurgy. On the other hand, if the sheet is heated slightly, the hydrogen is driven off and the iron becomes ductile.

New avenues in industry seem certain to be opened by this method. The iron powder can be molded into high-precision gears in a single press operation, producing a gear that needs no machining. The advantages of electrolytic iron are not limited to manufacturing, according to Mr. Ford. Motor-car performance may also be improved by using it. For example, cores of distributor coils now in general use sometimes tend to lose their high spark efficiency at high speeds because the core remains partly magnetized between spark impulses. The electrolytic iron cores produced in the laboratory have shown high spark output at all speeds because this type of iron does not retain magnetism between electric impulses.

Of first importance in the decision to push the research program through to success was Mr. Ford's concern for communities near iron mines which had been abandoned because of the low quality of the ore. This has happened in several places in Upper Michigan. "Nobody wants that impure ore now because it costs too much to handle," says Mr. Ford. "If ore doesn't contain at least 40 percent iron, it isn't considered worthwhile to ship it to the furnaces. A lot of the ore in Upper Michigan is 20 and 30 percent stuff—it's full of dirt and other impurities. And that's just the kind of ore we have experimented with in working out our method of iron recovery."

CONDUCTIVITY CHECKS

Prove Their Value in Many Processes

BECAUSE of simplicity, accuracy, speed, and moderate cost, the electrolytic conductivity method of measuring and checking many materials is coming into extensive use in laboratories, industrial plants, and in the field. This technique can be applied to a wide range of chemical values, solution concentrations, water purity, the degree of rinse, and other matters. Indeed, whenever the electrolytic conductivity of a given item can be correlated with the desired factor such as concentration or moisture content, the conductivity bridge serves as the logical measuring and checking means in providing precise readings at the mere twist of a knob, thereby eliminating troublesome, time-consuming procedures, often requiring chemical analysis.

The conductivity bridge, of the type built by Industrial Instruments, Inc., for example, measures specific resistance of electrolytes from .2 to 2,000,000 ohms. Accuracy of measurements comes within 1 percent except for extreme ends of calibration, and is entirely independent of line voltage variations.

The conductivity bridge plays an im-

portant role in checking distilled water for purity, dissolved solids concentration of tap water, boiler feed water and condensates, acidity or alkalinity by conductometric titration, and water used in various processes where special characteristics are desired.

Many organic compounds in the pure state have exceptionally high specific resistance. Slight traces of impurities in these compounds, including traces of water, decrease the specific resistance to a marked degree. Conductivity measurements have therefore been found to be extremely valuable in detecting traces of moisture or impurities in organic compounds, and in some cases have been made part of the specifications since conductivity will reveal the presence of infinitestimal amounts of contaminant, or moisture, which defy other methods of analysis.

And of course the conductivity bridge can be used as a standard Wheatstone Bridge for conventional electrical work such as checking carbon and wire-wound resistors, calibrating rheostats and potentiometers, checking leakage, and so on.

COFFEE SEARCH

Fails, but Points to Better Diesel Filter

How one man's passion for good coffee resulted in a unique industrial contribution to the war effort was disclosed recently by the Moraine Products Division of General Motors. Better Diesel engines for submarines, tanks, trucks, and other vital power applications are being produced because Earl Patch, Moraine Products sales manager, wanted a better cup of coffee and didn't know how to make it.

Here is how the story is told:

Item 1. Moraine Products, a pioneer in the field of powder metallurgy, makes bearings that soak up oil the way a sponge absorbs water.

Item 2. One day Earl Patch brought a percolator to the office and said: "If we can make a piece of metal that will soak up oil, why can't we make a piece of metal that will drip coffee?" "Why not?" answered Roland Koehring, research engineer.

Item 3. Fortunately, neither Patch nor Koehring knew a thing about scientific coffee making. If they had, they never would have tackled the job. They experimented and experimented but without success.

Item 4. Then J. H. Davis, general manager, got interested. He suggested another approach, an approach so simple it had never occurred to the others.

Item 5. The new method works. Out of the sintering furnace comes what looks like a cake of coarse, bright-colored sand similar to those made by children. But, unlike a sand cake, it doesn't crumble.

Item 6. The first batch of coffee is perfect.

Item 7. The second is fair.

Item 8. The third is terrible.

Item 9. From a book on coffee Patch and Koehring learn why. They learn that the grounds lodged in the pores of the filter and turned rancid. They learn that a coffee expert can even spot a cracked cup by the taste of the beverage.

Item 10. But the story has a happy ending. The filter was found to be just the thing engineers of the Detroit Diesel Engine Division of General Motors were looking for to prevent the tiny holes in Diesel fuel injectors from clogging.

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BUSINESS BUILDER: As a result of industrial research, every fourth worker is working today in an industry which did not exist 40 years ago.

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SOYBEAN FIBER

Now Being Produced on Limited Scale

Limited production of a synthetic fiber developed from soybeans—a fiber similar to sheep's wool—has been announced by the Ford Motor Company. Spun from a molasses-like substance that contains soybean protein as its principal ingredient, the fiber is derived from the lowly farm crop that has come into industrial prominence.

The company has been operating a "pilot" mill at its Highland Park plant for several months which is capable of spinning upwards of 1000 pounds of the fiber a day. For the present, the fiber production rate will be maintained at approximately this figure in a new plant in Dearborn.

The synthetic product is said to be best used when blended with sheep's wool. Research chemists who developed the material estimate that eventually the thousands of pounds of wool now used annually in upholstery can be supplemented by at least 25 percent of this new fiber. Early production will be put to this use, for which the new product is ideally suited because of natural crimp and a high degree of resiliency.

The complicated processing of the soybean begins with the extraction of the oil. Protein from which the fiber is made, after being removed from the oil-free meal, is dissolved to produce a viscous substance that emerges from a 500-hole spinneret looking not unlike fine noodles. The extruded filaments are run through an acid bath and later, after immersion in formaldehyde to completely set the fiber, they are cut to desired staple length and dried under controlled temperature and humidity conditions. The fiber is then submitted to a half dozen other operations, all of which prepare it for spinning. After being spun, it is shipped to the upholstery mills. Wool and other fibers are added there.

PIPE LINES

Many Miles Built During 1941

America's "underground railway," its network of petroleum pipe lines, gets longer every year. In 1941 the petroleum industry added more than 4500 miles of this unsinkable transportation to its systems, about half of it in strategic locations directly concerned with national defense. The remainder was built in the normal, continuing expansion of an industry which finds new oil fields every year and must connect them with its refineries; refined products are also carried from the refinery to the market by pipe lines.

MANGANESE

From Low-Grade Ores In the United States

Manganese sufficient for all our national needs can be produced right here in the United States as the result of a new process for the treatment of low grade ores developed by the Bureau of Mines. Success of the process depends on the use of a new reagent developed as a result of researches in the laboratories of the Bureau of Mines, and known as DLT-958. This reagent floats a good part of the worthless materials away from the ore, leaving a concentrate from which the metal can be extracted by the usual process. The Bureau has also developed other reagents of a similar character.

The Bureau has built, under a defense appropriation, a group of pilot plants at Boulder City, Nevada, of which the first unit has begun operations. The first test of the new reagent was made in this mill on ore containing 18 percent of manganese. It left a concentrate containing 53 percent of manganese.

INDUSTRIAL TRENDS

THIS RUBBER SITUATION

Up to the tragic date of December 7, 1941, the chemical industry of the United States was planning, in the orderly manner typical of past performances, for production of various materials for national defense. But the bombs at Pearl Harbor changed all this. Where minor shortages of materials existed before, there were found drastic scarcities; where experimental planning for future possible production had been underway, there suddenly loomed the necessity for full-scale operation of plants still on the drawing boards.

Synthetic rubber was the one product of the chemical laboratory that received the greatest publicity after the declaration of war bit even deeper into the already critical situation in natural rubber. But even today, months after Pearl Harbor, there is still some misunderstanding about synthetic rubber and its production possibilities.

First, it must be understood that the term "synthetic rubber" applies not to one product alone, but to a number of synthetics produced from a variety of raw materials. Secondly, it is not the scarcity of these materials that is the choke point in synthetic rubber production; plants must be built, and electric power must be provided for operation.

The chemists are ready with a variety of formulas for compounding synthetic rubbers. For some time past Du Pont has been making neoprene from an acetylene base, the resulting product having been proved by practice in a number of industrial applications. Vinyl plastics, by Union Carbide and Carbon, have been substituting for rubber in many fields. Koroseal, a synthetic produced by Goodrich, is being pushed to greater production figures than ever before, and a vehicle tire of synthetic rubber is being made by the same company. Standard Oil of New Jersey will soon be heard from in a big way with another synthetic for tires. Into the same picture come Dow Chemical and American Cyanamid as suppliers of raw materials and Monsanto as a source of processing chemicals.

In the meantime, research laboratories are working overtime on new formulas for producing the synthetic rubbers. The possibilities are almost unlimited, there being literally hundreds of basic chemical forms, obtainable from coal, or oil, or both, that can be combined with other materials to produce innumerable types of synthetic rubbers with varying characteristics to suit almost any designed purpose.

It appears now that, subject to change without notice, the aim of the whole synthetic rubber industry will be toward capacity for producing some 150,000 tons annually; this is about half of the probable ultimate production that will be necessary, it being estimated now that the goal of this industry must be placed at producing about half of our 600,000 tons of rubber consumed annually. By the time the 150,000-ton point has been reached, it is probable that research will have developed newer and better synthetics that can be produced at lower cost.

In any consideration of this important phase of our all-out war effort, it must be remembered that chemists in the synthetic rubber field are working under a suddenly imposed handicap. For years they were experimenting in this field without any immediate pressure other than that of producing a material with industrial possibilities. Then came the natural rubber shortage—and insistent demands for synthetics in large-scale production. There are, thus, many phases yet to be fully explored, phases that will undoubtedly change the synthetic-rubber picture when they have been opened up by the ingenuity of American chemists.

50 PERCENT PRODUCTION

An industrial production figure that has been widely quoted, but without sufficient explanation, has led to some misunderstanding regarding the total war effort of American industry. This figure places war-production requirements of all sorts at only 50 percent of the total productive capacity of the nation. This would seem, on the surface, to indicate a possibility of business as usual for many companies engaged in businesses outside the war effort. But the figure is one of those misleading overall estimates; there are thousands of firms engaged in luxury-item and other non-essential production that are finding raw materials more and more difficult to obtain. Many of these will be forced out of business, some will obtain only a bare minimum of supplies, while a few will be affected only slightly.

Unfortunately, that 50-percent figure can be spread only just so thin; then it tapers off to nothing.

PUTTING WORDS ON PAPER

Typewriter manufacturers are feeling the demands of war production in two ways. The typewriter itself has become an implement of war, lubricating the wheels that produce the enormously increased amount of paper-work in defense industries and in government departments. At the same time, materials shortages have struck at typewriter production a bit harder, if anything, than at many other industries.

It is encouraging, therefore, to note, in a recent report from the Royal Typewriter Company, that these shortages have had, in certain aspects, a beneficial effect on the industry as a whole. Substitutes for critical metals have been developed and design improvements, incorporating these alternate materials, have been made. Net result is being shown in better machines for putting words on paper, and the foreshadowing of even more efficient machines for lubricating the wheels of peace in days to come.

IN NEW DRESS

The packaging industry in general is hard at work following the general trend of re-design made necessary by the withdrawal from civilian use of many materials heretofore considered essential. Thus research is being directed toward plastic and paper tubes to replace the collapsible metal tubes used for toothpaste, shaving creams, and so on; the tin, lead, and aluminum formerly used will soon be out of this particular picture. Glass and wood are other possible alternates for use where the material to be packaged can be adapted to such containers.

Beyond substitutions in this industry there is a definite trend toward simplification of containers of all sorts. Soon will be gone ornate wrappings on soap and similar products. Double paper coverings will be a thing of the past. Possibly some industries will even turn attention to the design of packages which can be opened by the average person without the loss of at least a fingernail!

—The Editors

'Water, Water, Everywhere'

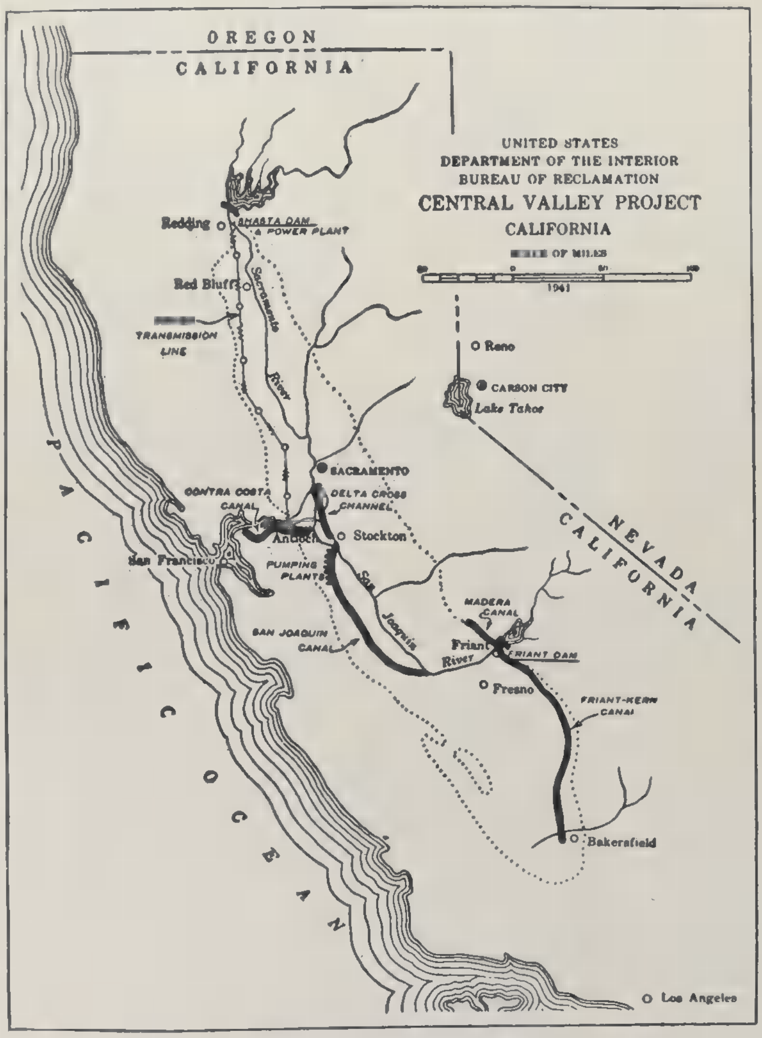
Multiple-Purpose Central Valley Project in California Involves Huge Dams, Five Canals

ANDREW R. BOONE

FROM sky-scraping Shasta Dam on the north to Bakersfield on the south, beneficiary of water to be carried by canals stretching like tentacles up and down California's great Central Valley a total distance of 393 miles, it's a case of "Water, water, everywhere."

The United States Bureau of Reclamation looks upon the Central Valley Project as holding greater potential benefit, both locally and nationally, than any conservation project attempted in its 38-year history. This undertaking is a multiple-purpose project, involving construction of two huge dams, Shasta and Friant, and five canals, which jointly will:

Improve navigation on inland waterways, reduce floods in the Sacramento and San Joaquin River valleys, furnish water to irrigate 2,000,000 acres of highly productive agricultural lands, control salt-water encroachment in the delta region of the two rivers mentioned, improve domestic and industrial water supplies in central California, and develop hydro-electric power for municipal, agricultural, industrial, and project uses.



Area covered by Central Valley Project

What the system of canals, and the water they will carry, mean to agriculture and industry may be noted in these facts and figures:

During the last season, ten times more rain fell at Kennet, in the northern end of the project, than at Bakersfield, near the southern tip. Kennet, in the future area of Shasta reservoir, which will back up 35 miles and impound 4,500,000 acre feet of water, received a total of 112.76 inches, while 11.61 inches (twice normal) fell at Bakersfield. Some of Kennet's surplus will flow into the north and central parts of the valley, and make available San Joaquin River water for diversion to the arid southern end of the valley.

Already, water is being delivered via the Contra Costa canal to Pittsburgh, an industrial city located in the upper bay region 40 miles east of San Francisco. Necessity for this supply arises from an increase in hardness of the local well water from 155 to 800 parts per million in 19 years, and difficulties of pumping against a head of 225 feet. Canal water is now being substituted for this and other pumped water.

Shasta Dam serves a far more important function than any other individual unit of the Central Valley project. "Shasta reservoir," explains Walker R. Young, assistant chief engineer for the Bureau of Reclamation, "will be operated to diminish the seasonal flood flows of the Sacramento River and thereby check annual waste to the sea of precious water, and correspondingly to increase the natural output of the river during dry months for purposes of navigation, irrigation, and salinity control. Reservoir releases will generate electric power to be carried by project transmission lines down the Sacramento valley to load centers. Finally, after the conserved waters of the Sacramento River have served all these functions and we have wrung the last squeal from the last drop, they will afford a surplus for export to the upper San Francisco bay region and San Joaquin valley through other features.

"These include the Delta Cross Channel to divert Sacramento River water across the delta, Contra Costa Canal leading from the delta westerly to a bayshore industrial and agricultural area, San Joaquin pumping system from the delta into the northern San Joaquin valley, and Friant-Kern and Madera canals to serve the southern San Joaquin valley. All these depend, directly or indirectly, upon Shasta Dam. In fact, no one feature can be fully utilized unless some or all the others are in operation."

Shasta—higher than Grand Coulee, second largest masonry dam ever built, with half again the mass of Boulder—staggers the imagination when you consider its proportions. Located 12 miles above Redding, on the Sacramento River, it will be 560 feet high and 3500 feet long. Six million yards of concrete will be placed before water climbs toward its crest.

Shasta will consist of a mass of pre-shrunk individual blocks, cooled by circulating river water through pipes imbedded in the mass. Upon completion of the blocks, they will be joined by pumping grout through another system of pipes, permanently imbedded for this purpose. Finally, a power plant, housed in a seven-story building, will involve operation of five 75,000-kilowatt generators turned by turbines developing 103,000 horsepower. The generators weigh 4250 tons, and 174 railroad cars will carry them from the manufacturing plant to the dam site. Of the 1,500,000,000 kilowatt hours of electrical energy developed each year, one-fifth will be utilized for project pumping, and the remainder made available for civil use.

Perhaps the most unusual feature connected with Shasta is the long ag-

gregate delivery line. Were you abroad any morning in the vicinity of Shasta, say at 7:45, you would hear the combined blast of 30 horns stretching in a line 10½ miles long across the hills. And, were you standing alongside a small house at Coram, you would see an operator press a button starting a quarter-mile of loaded belting, known as flight 26, moving. In a few seconds, flight 26 would be up to speed, precisely six miles an hour, at which instant, flight 25 would commence turning. Six minutes after the button makes contact, all 26 belts, forming an endless delivery chain from the gravel plant at Redding, are rolling, carrying their load of 1700 tons of aggregate toward the hoppers at Coram. By nightfall, 20,000 tons of material, the equivalent of 400 freight cars, will have been delivered.

Two conveyors at Redding alternately feed the main line. One runs under a huge sand pile, where it is loaded by several drawdown gates. The other extends under gravel piles, for loading with different size gravel. The loading operator "ships" one size aggregate for one hour, then shifts to another. When a change is made, he 'phones the operator at Coram. Exactly 88 minutes later, the Coram operator, noting a minute gap in the stream, notifies a shuttle operator to shift the delivery from one bunker to another, and delivery continues. The shuttle conveyor is shifted quickly to any of five bunkers.

This conveyor has been spoken of often as being a "ten-mile belt." It really consists, however, of 40 belts. Aggregate in the first eight miles is lifted 850 feet in 22 flights. During the next four transfers, it descends 700 feet, the motors acting as generators to restore some of the power consumed on the long uphill climb. At Coram, it starts another 14 flights for a 1.2-mile travel, at the end of which it goes through a 150,000-ton storage pile before being mixed with concrete and swung out over the canyon for placing in Shasta Dam. Total length of the 40 flights is 10.8 miles, and before Shasta is completed they will have transported 11,000,000 tons of sand and gravel to the site.

How concrete embodying the aggregates delivered along the belt line is placed represents certain engineering novelty. Flights seven to 14 of the second conveyor system transfer the aggregates from stock piles around and over the abutment to small storage bunkers at the top of the mixing plant.

This plant bears the appropriate name, "The House of Magic." During a single day's run, this plant mixes 10,000 cubic yards of concrete. The order of mixing is fully automatic, and is controlled by four men. The plant is hexagonal in shape, stands 130 feet high, and is fabricated of reinforced concrete and structural steel. At the top are five bins capable of storing 2165 cubic yards of aggregate, and two bunkers carrying 3200 barrels of cement. Following mixing, the cement is discharged into a hopper for the distribution cars, which operate on a circular track 420 feet in diameter. This track circles the base of the head tower, and over it the concrete is carried to the various highline buckets.


Shasta Dam, conveyor belt in background

You'd have to climb 257 feet to reach the hoist floor. In it you would find seven large three-drum hoists. Lines from the hoist drums lead to the top of the tower and through sheaves to individual cableways. Tail towers for the cableways are mobile, and operate on five radial runways. Each tower is controlled by an individual operator. From his station, the operator can move the bucket out, lower it, trip it, haul it up, and bring it back for reloading. All buckets used on the high lines carry eight cubic yards, and are permanently attached.

Friant Dam, near Fresno, will be completed sometime in 1943. Aside from a certain measure of flood control, Friant will have little value until its connecting canals are open into areas of critical water deficiency, especially the 160-mile Friant-Kern canal, of 3500 second-feet initial capacity, under which more than half the service area of the Central Valley Project is situated.

Friant presents a construction picture differing markedly from Shasta. No huge tower and cableways here. Rather, a giant trestle stretches from one side of the valley along the line being followed by the dam. Immense cranes, known as "hammer-heads," move along the tops of the trestle. From the cranes buckets of concrete are lowered. So high do the cranes stand above the valley they can continue handling the buckets until the dam is completed.

Friant's "house of magic," or mix-house, is located at one end of the trestle, and is fed with aggregates by means of a belt conveyor and cement through a pipe line similar to the Shasta arrangement. Railroad cars, each carrying four four-yard buckets are hauled from the mix-house along the trestle to the dumping area. There, cranes pick up the buckets singly, raise them in an arc to the dumping point, and return them to the cars. By this means, 5000 cubic yards of concrete are placed daily.

Like Shasta, Friant offers some new construction methods and practices. It is smaller than Shasta, yet a whopper in its own right. Friant will be 320 feet high and two-thirds of a mile long. With 2,200,000 cubic yards of concrete finally in place, it will be exceeded in size only by Grand Coulee, Shasta, and Boulder.

On the downstream face, which will be exposed to weather except during brief periods of overflow, an absorptive lining is used in the forms. This material is quite porous, and has the property of soaking up water as the concrete is poured, causing the surface to become more dense by drawing fines to the surface. Because the surface is denser, it will resist weathering longer.

The Central Valley Project not only will insure water for California's lush agricultural production. It also will restore thousands of acres lost in recent years to production because of water scarcity, and guarantee water to such defense industries and military establishments as may spring up in this region. All together, it represents a mighty effort at conservation which bids fair to yield tremendous returns in many fields.

New Pleiades

Recent Investigations of Proper Motions Have Added Two Dozen More Stars to the Famous Cluster

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University; Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

ONE of the most conspicuous objects in the sky is the cluster of the Pleiades. The brightness of its stars and their apparent closeness set it apart at a glance, and it was doubtless recognized long before the Greeks gave it the name by which we still know it.

Six stars are easily seen by any normal eye; keen eyesight may raise the number to eight, or even to ten. A field-glass shows dozens, and telescopes reveal numbers steadily increasing with their power. With a modern instrument, of high light-power, it would be easy enough to photograph 10,000 stars within two degrees of Alcyone—the brightest star of the group.

But, if we pointed such a camera to any other part of the sky and made an exposure of equal length, we would find a great number of stars on an equal area of our plates. The sky is full of faint stars everywhere, and there can be no doubt that our photograph of the Pleiades region must show a host of "field-stars" which have no connection with the cluster—most of them lying far behind it, and a few probably in front. How can we allow for this? The presence of the cluster should make no difference in the distribution of the stars seen in front of it or through it. We may expect to find the same number of field-stars per square degree as in other regions of the sky. Any excess (over and above the fluctuations reasonably attributable to random sampling) may be ascribed to the cluster.

For example, Trumpler, counting the stars of the Bonn Durchmusterung—which goes down to about the tenth magnitude—finds, for the number of stars in the vicinity of the Pleiades:

Distance from Center	Number	Number per square degree	Field	Cluster
0°—1°	63	20.0	12	51
1°—2°	56	5.9	36	20
2°—3°	79	5.0	60	19
3°—4°	87	4.0	84	3
4°—5°	104	3.7	108	(—4)

The number of stars per square degree, in the successive zones, falls off to a nearly uniform value of 3.8, which may be taken to represent the "field." If this was uniform, the number of field stars would be as given in the column captioned "Field." The excess of the actual numbers should represent the cluster members. The values 3 and —4 for the two outer zones are evidently due to random irregularities, but it is evident that the Pleiades cluster stars extend to about three degrees from the center. Within this region there are 90 cluster stars, and 108 field stars—with a probable uncertainty of not more than five.

BY such counts it becomes certain that, among the fainter stars in this region, we must have hundreds of cluster-members, mingled indiscriminately on our plate with a larger number of wholly unrelated ones. To separate the two would be a thankless task, were it not for one fortunate thing. The Pleiades cluster is not at rest in the heavens. The brighter stars, which have been very accurately observed, are moving, slowly but definitely. Measures of their relative positions, made long ago, with the heliometer (then the most accurate instrument) and later by still more precise photographic methods, show that they do not change their distances and directions from one another at any perceptible rate, while the meridian observations reveal a motion of the whole group together southward and eastward, at the rate of 4″.8 per century.

This is a rather slow motion for stars as bright as the leading members of the group; but in 20 years it displaces the cluster by almost a second of arc. Measures of a single good photograph will locate even very faint stars with an error less than a tenth of this. So the astronomer who is lucky enough to have an old plate of the Pleiades need only take another—with the same telescope and of just the same region—measure the star-images on both, and apply the simple corrections which allow for the fact that the two plates were not put into the measuring-machine in exactly the same position. The great bulk of the fainter stars will show little or no change of position in 20 years—they are too far away. The nearer ones (and a few more distant ones whose actual velocities in space are great) will have moved, compared with the rest. Those which belong to the cluster will have moved by the amount and in the direction which follows from its known yearly motion, and can be picked out by simple inspection of the list.

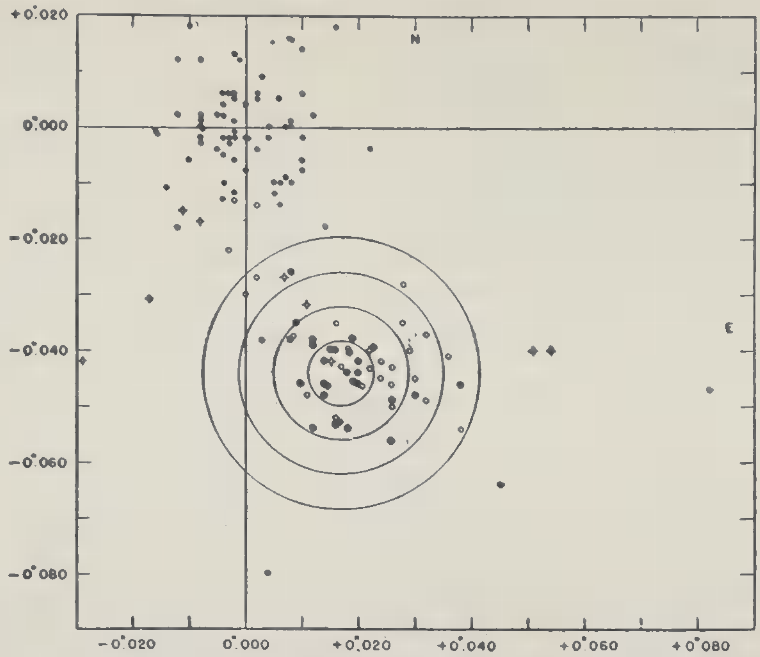
By sheer luck, a star or two out of the hundreds on the plate might appear to be moving in this direction and at this rate, though not really connected with the cluster, and so might get into the list where it did not belong. But this demands a double coincidence of direction and rate of motion, which is very improbable. The fainter the stars considered, the slower their average proper motions will be, and the smaller the probability of such an accident.

EVEN the best observations cannot be perfectly accurate, hence the final list has to be divided into three classes—stars whose observed motion agrees so closely with that of the cluster that it is almost certain that they belong to it; stars for which the discordance may arise from an accidental heaping up of the errors of observation, and which are "probable" members; and those for which the discordance exceeds any reasonable allowance for these errors—which are dismissed as non-members. The majority of these will be slow-moving background stars—seen through the cluster. A few, which move faster than the cluster, or in different directions, may lie in the foreground, or at more or less the same distance but do not belong to it.

Trumpler, in 1921, and Hertzsprung, in 1929, applied this method to the Pleiades. The latter listed 187 cluster members in a region two degrees square centered on Alcyone—some of them as faint as the 16th magnitude. The question whether still fainter stars—and how many—might be present could be answered only by long exposures with great telescopes. This has just been done by van Maanen at Mount Wilson. A few plates of the Pleiades had been taken with the 100-inch telescope in 1921 and 1922—covering a field 42 by 31 minutes of arc, with Alcyone in the center, and showing images of stars down to below magnitude 17.5—about 800 of them in this small area of little more than one third of a square degree. The best of these plates, compared with some lately

taken, gave two pairs with intervals of 15 and 19 years, upon which the motions of stars belonging to the cluster would be conspicuous. Indeed, when the earlier and later plates were "blinked" with the stereocomparator, 70 stars out of the 800 were found to have moved perceptibly. All these, regardless of their direction or rate of motion, were measured. It would have been an obvious waste of time to measure all the 730 other stars, only to get no perceptible motion. Sixty-seven of them—distributed evenly in position over the plate, and in magnitude between 13 and 16.5—were chosen as comparison stars, and sufficed to define a distant and substantially motionless background.

Of the 70 moving stars, 39 showed motions so nearly identical with that of the brighter stars of the cluster that their membership in it was practically certain; 9 others agreed well enough to be recorded as probable members, 8 were doubtful, and 14 clearly did not belong. Six of the latter turned out to be moving slowly, and probably were members of the background, while the other eight moved as fast as the cluster or faster, but in other directions or at other rates.



This diagram shows the rates of motion of the stars in the Pleiades observed by van Maanen. Imagine a set of points, each starting at the intersection of the lines marked 0.000, and each moving at the same rate and direction as one of these stars. At the end of a year they would present the appearance shown in the figure. The comparison stars (represented by the small black dots) are very remote, and move very little—indeed, their scatter about the starting point arises mainly from the small errors of observation. The large group of dots lower down and to the right represents the members of the Pleiades cluster which (within the errors of observation) are moving together. The black dots represent stars previously identified by Hertzsprung; the open circles, those found by van Maanen. Points inside the inner circles indicate almost certain members of the group; the next circle includes the "probable," and the last, the "uncertain" members. This group of points is almost completely separated from the one which corresponds to the "background" stars, and provides conclusive evidence of the existence of a moving cluster in this region. The small circles elsewhere in the diagram indicate "foreground" stars of relatively fast motion. From *Astrophysical Journal*

In this small area, then, there are almost certainly 39 and probably 48 cluster stars. This includes 26 previously identified by Hertzsprung; hence the inclusion of stars about two magnitudes fainter has nearly doubled the number. If the same proportion holds for the regions not yet photographed with the 100-inch, there must be about 350 cluster members in the two degrees square, and very likely 800 in the whole cluster, which extends beyond this but thins out rapidly.

There is no sign at all that the limit of faintness has been reached. Including the "possible" cluster members, there are 13 stars in the well-observed area between magnitudes 6 and 10; 10 between 10 and 14; and 31 between 14 and 18 with the last count incomplete.

It would be a conservative guess to say that there must be at least 2000 stars in the Pleiades cluster, and that fully half of them are too faint to photograph with the 100-inch telescope—but of course this *is* a guess.

The distance of the cluster—though too great to measure directly—is fairly well determined by a study of the absolute brightness of its stars, and appears to be 400 light-years. On this basis, the faintest cluster stars so far observed have an absolute photographic magnitude of +12—which means that they give out about 1/400 as much violet light as the Sun.

Hertzsprung has found that the faint cluster stars are all red, and redder the fainter they are down to his limit of observation at the 14th magnitude. The newly discovered members are doubtless still redder, typical faint dwarfs of spectral class M, running down to about 1/150 of the Sun's visual brightness.

Alcyone is 2000 times as bright as the Sun (photographically) and almost a million times brighter than its faintest known associates in the cluster. As in similar cases, this enormous difference doubtless arises from the concurrent operation of several factors. Alcyone is more massive, larger, and, above all, much hotter on the surface than its tiny neighbors. All but the brightest of the Pleiades appear to be normal main-sequence stars—heat-engines working in the same way and deriving their energy from the slow transmutation of hydrogen into helium by means of the now well known "carbon cycle."

Alcyone and a few others are abnormally bright for their spectral type, and their internal composition or constitution must be somewhat different. Unfortunately, none of these bright stars is double, and we cannot therefore find their masses, which might give us a clue to the reason for their peculiarities. There are several double stars, with slow orbital motion, among the fainter cluster members, and these appear to be of normal mass for their brightness.

To study still fainter stars, we must leave distant systems like the Pleiades, and search among the nearest stars. These are still being picked up, as parallaxes are measured for the faint stars of large proper motion which are detected by systematic "blinking" of pairs of plates taken years apart.

There is still good hunting for the observer here. Dr. van Maanen, reporting on his last 25 parallax fields, finds eight stars—one of them double—within 50 light-years. Four of them are less than 30 light-years away, and two of these are really our near neighbors, with distances 10.3 and 11.2 light-years. These stars, like almost all faint ones, are known only by their numbers in the catalogue of the observer who discovered their motions—Ross 128, of magnitude 12.7 and Luyten 789-6 of magnitude 14.3. The second—and nearer—of the two is noteworthy as having the largest proper motion of all the stars found by Luyten in the great survey which he has made. Its motion of 3".27 per year is exceeded by some 15 other stars, but none of these is as faint. The absolute magnitude +16.8 indicates that its photographic brightness is but 1/30,000 part of the Sun's, while its spectrum M6 marks it as one of the coolest dwarf stars which has ever been observed.

Shockless Surgery

Ice Anesthesia, Boon to Aged in Limb Operations and a Promise for War Wounded in the Field

BARCLAY MOON NEWMAN

JUST in the nick of time, for use in saving the lives of thousands of war wounded—civilians injured in air raids and soldiers on the battlefield—comes a revolutionary technique in surgery. Bloodless, shockless surgery, without any other anesthetic than cold, has been developed by the New York diabetic specialist, Dr. Frederick M. Allen.

Also, for the first time in medical history, we have anesthesia of the whole living tissue substance, instead of the former crude anesthesia of nerves alone—hence a remarkable freedom from pain and from deadly shock.

Infection is rendered far less likely.

Emergency cases with shattered limbs can be painlessly, bloodlessly, shocklessly, transported great distances and, if necessary, kept waiting safely for many hours before operation; ice bags, a pail of cracked ice, or a special refrigeration apparatus, as well as a tourniquet, is all that is needed.

The patient is ready for immediate operation any time after the limb has been thoroughly chilled, without further ado, without even a local anesthetic.

Here is a veritable boon for China, for Russia, or on any battlefield where anesthetics, antiseptics, drugs, may be lacking; a boon, too, for the aged diabetic or sufferer from hardening of the arteries who must undergo operation for gangrene of the foot. More of the arm or leg can be saved, in young or old, than with the old techniques. More successful are the operations, which formerly, with the old techniques, were accompanied by a rather high mortality.

Though the first extensive trials were reported only within the past few months, this new "cold surgery" and "protoplasm anesthesia" are already adopted as routine in many hospitals, with City Hospital, New York, showing the way. At City Hospital, Dr. Lyman Weeks Crossman, Dr. Wilfred Ruggiero, and Dr. Vincent Hurley have used the new surgery in scores of gangrene cases, with such a high percentage of successes that the attention of the medical world has been attracted.

Most astonishing to the layman—and to many a surgeon, too—is the fact that a patient can eat breakfast while his wounded or gangrenous leg is being painlessly cooled to a few degrees above freezing, then can go into the operating room without further anesthetic or any drug whatsoever, chat with the nurse while the surgeon amputates behind a screen, and can return at once to the ward and eat a full lunch, as though nothing had happened. There is no pain, no shock—hitherto a great cause of weakness, and often of fading vitality long after such major operations.

Limb immersed hour and a half or more in ice water, cracked ice

In war wounds and in other emergency cases, where a limb operation or amputation is necessary, a rubber tube is used as a tourniquet to shut off the circulation, the degree of tension being just sufficient to stop all blood flow to the lower portion of the leg or arm. "The rule that a tourniquet cannot be applied to a diabetic or arteriosclerotic limb is set aside by cold," Dr. Allen points out, to the amazement of surgeons skilled in the older, very ticklish handling of gangrene in aged diabetics or others with poor circulation in the extremities. Then, the leg or arm is immersed in ice water to a level about one inch above the tourniquet. Weaker patients may lie with only a slight elevation of the head of the bed and, with the protection of a rubber sheet, the leg is placed on a layer of ice and then is covered completely with cracked ice. Or, again, rubber ice-bags may be used, salt being added to each. The newest development is an electrically refrigerated "blanket."

A 200-pound refrigerating apparatus serves four to six patients simultaneously, and can readily be fitted into an ambulance. Thus emergency cases can be prepared for operation en route —in fact, are out of pain, unshocked, uninfected, even unstrained in the meanwhile. The dual application of tourniquet and cold brings almost immediate, complete loss of sensation in the injured limb. The rest of the body can be kept as warm as desired. There is no general chilling above the tourniquet.

In ordinary hospital routine, where the case is one of gangrene and there is no bleeding, the limb may be first surrounded with a few ice bags at the level chosen for the tourniquet. Within five to fifteen minutes the skin is chilled so that the application of the tourniquet causes practically no discomfort. A preliminary morphine hypodermic or other sedative is sometimes used in instances where the patient is nervous and apprehensive, but otherwise no anesthetic or other drug is needed.

TESTS of the refrigeration are made by means of a thermometer held next to the skin. The desired temperature is about 40 degrees, Fahrenheit, eight degrees above the freezing point of water. This assures adequate chilling without risk of actual freezing.

"The time required for complete through-and-through anesthesia varies with the depth of tissue," Dr. Allen states. "It may possibly be as short as one hour for an emaciated shin, or as long as five hours for a rather thick thigh." Then, with the patient in the operating room, the limb is removed from its nest of ice bags or other refrigeration. Sterilization and operation are carried out as usual. The surgeon need not hurry: the chilled tissues stay cold long enough for an ordinary operation, and longer. For extraordinarily lengthy operations, the limb may be kept on a bed of ice bags. When the operation is complete, the tourniquet is released, blood rushes in, and any bleeding points are quickly caught and stitched up.

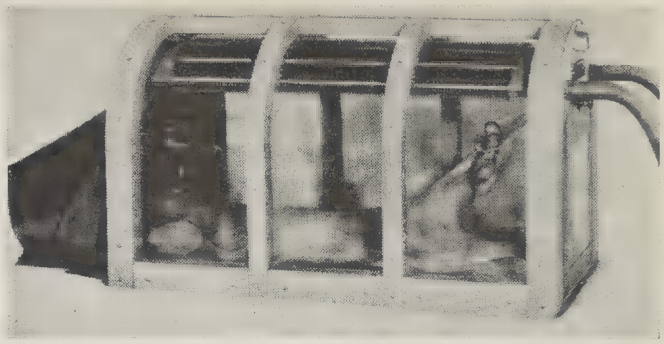
The surgeon has had the opportunity

of working in a bloodless and shockless field. Shock is at most that slight degree which may develop from the tissue injury left after the wound is finally closed and the temperature raised to awaken the "hibernating" life substance, protoplasm.

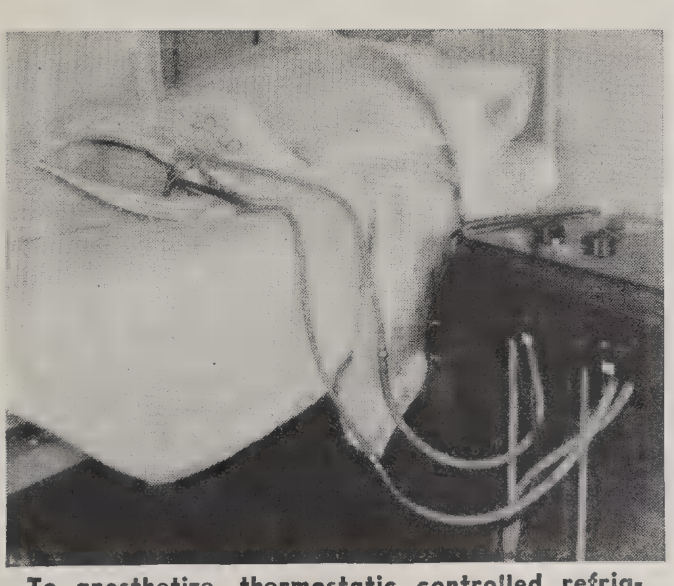
After the operation, the patient has neither nausea nor gas pains, so common in ordinary anesthesia. The practically complete absence of shock is evidenced by a steady pulse, constant level of blood pressure, steady rate of respiration—no changes occur during or after the operation. This is ideal for surgery of those who are so weak that ordinary operative shock would likely be fatal. In a series of more than 50 operations reported on at City Hospital, the average age was 68, and a number of these patients were four score years old. Almost all were suffering from heart disease, or diabetes, or hardening of the arteries, yet they successfully underwent the hitherto risky major operation of amputation. Formerly, four out of five died, when operated on by the older procedures. In the City Hospital series of cases four out of five lived.

NOT only shock but bacterial infection plagued the older surgery. We all know that refrigeration prevents the growth of bacteria. Doctors are all familiar with the preservation of living tissue in the ice box for weeks and even months—alive and uninfected. In cold surgery, as well as in the transportation of refrigerated wounded to the hospital, bacteria simply cannot grow.

After amputations, there is the ever-present danger of blood coagulation, sometimes extending rapidly up a limb and entailing a correspondingly rapid gangrene. Such phenomena are caused largely by damage of the blood vessel walls. Bacterial invasion may bring about the damage. In arteriosclerosis, damage to the walls arises from lack of nutrition and of oxygen, as well as from bacterial action. Now the clotting is prevented by cold, which preserves the vessel walls. Parts which have deficient circulation can be most effectively chilled and, by very gradual warming through several days after the operation, survival of the tissues is promoted. In ordinary cases under the new procedures, gradually lessening refrigeration is the rule, the manipulation of ice bags permitting a slow return to normal temperature. The wound margins can be kept healthy, yet not sealed. Discharge may continue abundantly. It cannot decompose or become infected, because enzymes and bacteria are checked by low temperature.



Electric refrigerator cradle for treatment of extremity — hand or foot — at low temperature



To anesthetize, thermostatic controlled refrigerator keeps "blanket" at 40 degrees, Fahrenheit

Of course, as Dr. Allen says, healing is slowed in proportion to the reduction in temperature. But there are advantages here, too. A whole series of important new controls become available when needed. When there are threatening signs of loss of vitality in wounds, the surgeon has previously had to stand helplessly by and watch the wound slough. The sloughing is due to deficient nutrition and oxygen. Now it is possible to reduce the tissue metabolism (use of food and oxygen) to a level for which the existing blood supply is adequate.

Ice-immersed extremity of patient lying in bed. Complete anesthesia in two and one half hours

The use of low temperatures opens up other striking possibilities — already realized in the hospital. In the most desperate cases, hitherto, surgeons have had to take the risk of a high amputation if the patient is to be considered operable at all. Such has been the situation in severe gangrene of the exhausted aged, diabetic, arteriosclerotic, and in rapidly advancing infections of the limbs of young or old. Refrigeration offers an alternative, and the tourniquet can add all the advantages of operation without the shock. The advance of infection, the pain, the downward trend of the patient, can be checked for several days by simple packing in ice.

Transfer of all these results to war conditions offers much. It offers the hope of transportation of limb casualties without hemorrhage, pain, or shock; without advance of infection or tissue devitalization; with minimum damage and maximum time limits of tourniquet application; and with freedom to operate without an anesthetic or to delay for several hours according to the exigencies of a crowded surgical service.

With regard to its practicability in war, refrigeration is usually available on naval vessels, and for modern mechanized armies the 200-pound apparatus is obtainable. This can be operated by the motor of a truck or ambulance and can refrigerate four to six limbs simultaneously, while ice is frequently available in less fortunate countries, from Finland to China, where the lack of anesthetics has entailed much suffering.

A large number of both military and industrial wounds consist of mutilations of limbs. In warm weather ice is often available or can be especially provided. In cold weather, only precautions against actual freezing of parts may be needed. The chilling is so simple that it can be carried out by reasonably intelligent non-medical persons. The tourniquet, of course, is necessary to stop hemorrhage, and under appropriate conditions of reduced temperature may be kept in place for several hours without risk. The transportation of wounded persons can be made entirely painless, as far as limb injuries are concerned. There is probably better

preservation of strength and resistance than with large doses of sedatives. The wounded may then arrive at a hospital after several hours, ready for immediate operation without any additional anesthetic.

Even when any parts are potentially infected, perhaps by being contaminated with dirt and other foreign material, refrigeration holds everything in abeyance. The preservation of tissue vitality and resistance to infection should facilitate conservative and reparative operations and aid in avoiding amputations and crippling. Much more of the limb may thus often be saved, or even whole limbs that would under the older procedures have been necessarily removed.

These achievements are indeed revolutionary. So much so that they might not yet have gained recognition except for the courage and vision of Dr. Allen's colleagues, Dr. Crossman and his associates, in applying them on a scale sufficient to convince other surgeons. The greatest obstacle was and still is lack of financial support. As Dr. Allen has written: "The only support for this research has come from the American Medical Association, in the form of a \$500 grant from its Committee on Scientific Research, for animal experiments, now conducted at the New York Medical College, and one of \$300 from its Council on Physical Therapy, for the clinical study at City Hospital in New York."

Except for these obstacles, there need not have been the long delay since the report of the first human cases in 1937, and the world-wide adoption might have been possible before the outbreak of the present war. It might have been the means of saving the lives of soldiers and civilians the world over.

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AGAIN GUILTY?

Do Flies also Spread Infantile Paralysis?

The case against flies as the culprits that spread infantile paralysis is strengthened by a discovery reported by Dr. Albert B. Sabin and Dr. Robert Ward, of the Children's Hospital Research Foundation and the University of Cincinnati College of Medicine, in the current issue of *Science*.

Flies caught in Cleveland and Atlanta in the neighborhoods of infantile paralysis patients were infected with the virus of the disease. Previous discovery of the infantile paralysis virus in flies was made in insects trapped in rural areas, in one instance near a privy used by three households in which there were infantile paralysis patients.

Discovery of the virus in city flies is considered more significant, especially since the infected flies were found in modern neighborhoods with good plumbing and in which several children had mild illnesses that might have been abortive infantile paralysis at about the same time other children had recognized attacks of the disease.

Flies as carriers of the disease fit with the theory, suggested by recent evidence, that the virus attacks through the alimentary or digestive tract rather than through the olfactory nerve from the nose. Suggestive also is the fact that the fly season and the infantile paralysis seasons coincide.

PRONOUNCIATION

Of Names of Two of the Sulfa Drugs

Not laymen alone, but physicians also, have differed widely in the pronounciation of the words sulfanilamide and sulfathiazole, two of the sulfa drugs. *The Journal of the American Medical Association* now states that the Council on Pharmacy and Chemistry of the Association has recommended that the word *amide* be pronounced with the long *i* (amīde). Thus it rhymes with chloride and iodide. In the word sulfanilamide the syllable *il* is given the major accent.

Sulfathiazole is to be pronounced similarly with a long *i*, and the accent on the *thi*.

INFECTION

Depends on Both Bacteria and Host

Like the modern blitzkrieg and its aftermath, extremely virulent bacterial infections actually are ineffective from the standpoint of the bacteria, as parasites, because the microbes so rapidly destroy the tissues upon which they live and grow, according to Dr. Paul R. Cannon, professor of Pathology at the University of Chicago.

Time plays a commanding role, in infections, as important in the incipient stages as it is in a beginning forest-fire, said Dr. Cannon, continuing:

"The ability of bacteria to grow in living tissues depends upon forces inherent in both the bacteria and the host.

"At times, with highly virulent bacteria, this ability to grow is so predominant, that, under proper conditions, they can multiply rapidly, metabolize efficiently, and overcome quickly all efforts on the part of the host to prevent these actions. This type of infection, fulminating in development and quickly lethal in course, represents the maximal biologic growth efficiency of the bacteria concerned."

A return of scourges like the "Black Death" cholera and typhoid fever today is not so threatening as it was when these diseases ran riot in Europe, Dr. Cannon said, because of modern methods of keeping invading bacteria localized, and their toxic action checked until they can be destroyed by the defensive forces of the body.

PREGNANT?

Electric Recordings of Unborn Baby's Heart Beats

Electric recordings of the heart beats of an unborn baby can now be made successfully for practical purposes by means of a technique announced by Dr. Arthur J. Geiger, Dr. Willys M. Monroe, and Dr. Allan V. N. Goodyer, of Yale University School of Medicine, in the *Proceedings of the Society for Experimental Biology and Medicine*.

Doctors have tried for years, hitherto with only indifferent success, to obtain electrocardiograms of the unborn baby's heart beats, although these graphic recordings of the electric current produced by the heart muscle contraction have long been used in studying heart disease.

The new technique, the Yale investigators report, enables the doctor to tell promptly whether a woman is about to become a mother or whether she has a tumor. It does not give "false positive" results and takes less time than mouse or other biological tests for pregnancy.

"Will it be twins?" can be answered much earlier than by any other method of examination.

In their work the Yale doctors use a single stage resistance-coupled amplifier with a conventional portable electrocardiograph. The electric current accompanying the unborn baby's heart beats is picked up by disk electrodes placed on the mother's abdomen. They are amplified 20 times, which brings the recording into plain view, and the apparatus is arranged to minimize pickup of the mother's electrocardiogram. The small 12-pound amplifier of standard radio parts is simple to operate and can be easily carried with the electrocardiograph.—*Science Service.*

Torpedo!

Mechanics of the "Tin Fish" That is Writing a Terrifying Record of World-Wide Destruction

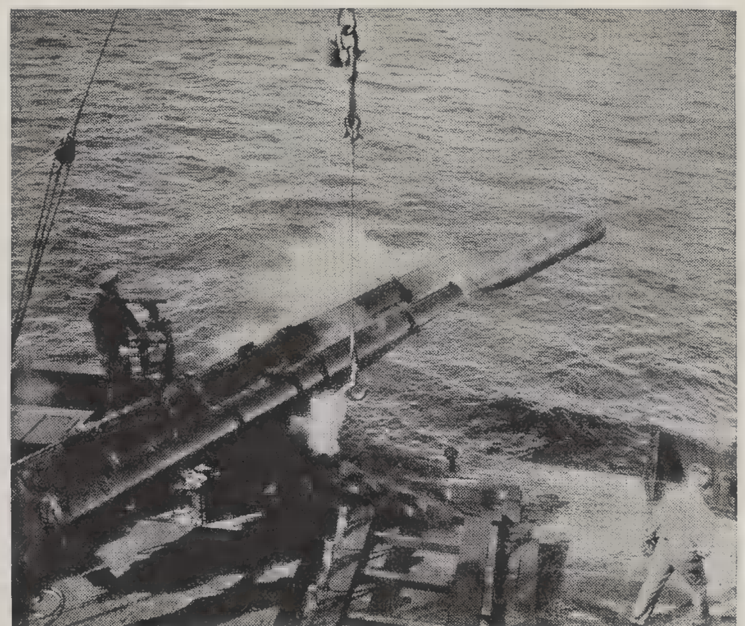
DONALD WILHELM

A TANKER, northbound with a cargo of oil, plows heavily through the Atlantic swell a few miles off Long Island. Suddenly the ship staggers as though from the blow of a titanic fist. A rending explosion rips open her side, and a torrent of water pours through the hole into the hull. Five minutes later she is awash. Then her bow slides under the waves. The stern tilts up, and she plunges to the bottom. A U-boat has struck again with the deadliest of modern weapons—a torpedo—against which the naval engineers have found no satisfactory protection.

Just what is this blasting hellion of the deep, this streamline horror called a torpedo? It is the most intricate and perfect engine of destruction which scientific military design has yet produced. It is the smallest warship afloat; 24 feet long. For it *is* a ship, complete in every detail. It has a wheel house, an engine room, a cargo, and a crew to steer and run it; a mechanical crew more precisely obedient than any human sailors. It takes and holds, exactly, the direction assigned its mechanical brain. If so directed, it will describe a complete semicircle before settling down to its course; or it will plunge ahead pointblank in the direction it is launched. It will travel precisely at the depth desired under the surface of the water. And it never wavers. Like a big battleship, it is given test runs and tried for any faults it may have before it joins the fleet.

A 3000-pound "fish" of steel with 600 pounds of high explosives in its warhead, it knifes through the depths at nearly a mile a minute, driven by more than three times the power of a V-8 car at full throttle. Without warning, it hits its victim with a blasting wallop which staggers even the heaviest battleship afloat. Britain's "unsinkable" *Prince of Wales* and Hitler's vaunted *Bismark* have succumbed to its sting.

Naval architects have tried every device they could think of to defeat the torpedo. "Torpedo bulges"—double hulls, constructed in the hope that the torpedo would explode between the outer and inner shells and not penetrate the ship's vitals—were tried and abandoned. Battleships are now divided into many compartments, so that if one is blasted by a torpedo, the others can be shut off from the inpouring water. But even these precautions are generally ineffective. The impact of a 16-inch shell is light by comparison to that of a torpedo. As Admiral Hart said recently: "When a torpedo hits anything, it stays hit."



Official U. S. Navy Photograph

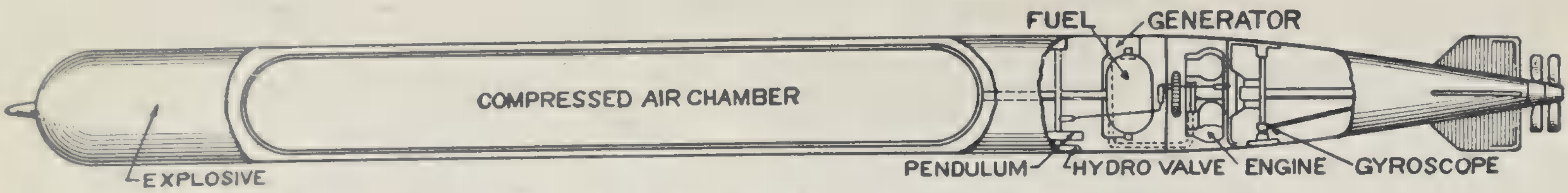
A "tin fish" takes to the water for test

This vicious little robot, capable of scuttling a vessel 20,000 times its weight, has made history in every naval engagement since the Japs sailed into Port Arthur in 1904. It nearly changed the outcome of the first World War, accounting for 2000 ships, totaling 6,000,000 tons. It was fear of torpedoes that kept the British from following up and destroying the German navy at Jutland. In the evil month of April, 1917, it cost the Allies nearly a million tons of shipping, a rate that soon would have stopped the beating of England's heart. Today Hitler is gambling on the torpedo to rupture the communication lines on which the Allied effort depends. Once again German U-boats lurk off our shores, waiting to send destruction—via torpedo—to the next vessel that comes within range.

Like most first-rate scientific achievements, the modern torpedo is a result of a long series of experiments, some of them abortive. Ever since ships first began fighting with gunpowder, naval men have sought means of bringing a large explosive charge against their enemies' hulls. In 1776 a scheme was proposed, but never tried, for breaking the British blockade of American colonies by approaching King George's men-of-war from under the water and fastening bombs to their bottoms. Later, Robert Fulton discussed with the governments of France and England his ideas for an underwater attack. The first torpedo actually to see service was the "spar torpedo" of the American Civil War. This contraption, a long ram with a bomb on the end of it, was a sorry forebear of today's "tin fish," but a terror in its day.

The torpedo as we now know it was born in 1864, when a Captain Luppis of the Austrian Navy went to the famous Scottish engineer, Robert Whitehead, with a plan for a self-propelled, self-steering underwater projectile. Whitehead, fascinated with the idea, began work at once, in a little shop in Fiume. Two years later the first Whitehead torpedo slid into the water—and worked. It was a crude little machine, only 10 feet long, traveling seven miles an hour by compressed air, and carrying 19 pounds of guncotton in its head. But it was the daddy of them all. So sound was the great engineer's work that his basic design has changed but little. Speed, size, and explosive power were increased, however, and by 1914 it was the most dreaded weapon on the high seas. With World War I, the torpedo came into its own.

THE early torpedo was notoriously tricky; even during World War I it was still a dangerous weapon to handle. So erratic was its course that it often menaced the mother ship more than the target; several German U-boats were blown up by their own torpedoes. They had other quirks. They left a wake of bubbles that betrayed the location of the mother vessel and often led to its destruction. They often jumped out of the water like porpoises. One U-boat commander's experience became a classic. Cruising on the surface, he was suddenly attacked by a



General arrangement of torpedo mechanism: Exact details are military secrets

British submarine. The Englishman fired a torpedo. The German saw it coming too late; he had no time to turn his sluggish craft, and stood awaiting his inevitable end. But as the torpedo was about to strike, it leaped out of the water, slithered across the U-boat's deck, and plunged harmlessly into the sea on the other side.

The torpedo of today—and the designs of different nations vary only in detail—has none of these vagaries. The world's navies have lavished the best brains available on getting the "bugs" out of it, made it so powerful it can knock a hole in the side of a cargo vessel even without its explosive head, so accurate it can run for miles without appreciable deviation from its set course and depth, so destructive that no ship that sails is safe from it. Its active life is short, ranging from a few seconds to six or seven minutes. When it misses, it runs for about eight miles, then automatically sinks, so it cannot be a navigation hazard or fall into the hands of the enemy. Its mechanism, comprising 3000 precision-built parts, is as intricate as that of a watch. To make one requires some thousands of man-hours of labor and $12,000 in cash. Foot for foot, pound for pound, it is the most expensive of all naval vessels. But it is the best investment any navy can make. Its one and only service voyage may decide the fate of a nation.

From bow to stern, the torpedo's 24-foot length is divided into four main sections. The first is the warhead, built like an armor-piercing shell containing 600 pounds of the most devastating explosive known. Behind the warhead is a large compartment holding compressed air, its main driving force, under the colossal pressure of 2800 pounds per square inch—several times the maximum in the most powerful locomotive boiler. Behind that are smaller tanks, in which the torpedo carries its own fuel, water, and lubricating oil. Another section is the "engine room," where the mechanical brain that guides the torpedo and the engines which drive and control it are housed. Finally, there are the twin propellers, revolving in opposite directions (a single propeller would only make the torpedo revolve in the water) and the two sets of rudders, one for direction, one for depth.

Torpedoes are launched from the tubes of submarines, the decks of surface vessels, or the bellies of airplanes—it's all the same to the torpedo. For it is every inch a seagoing vessel; once in its element—the water—it's a warship on its own. The duties of a launching vessel and its crew are merely to get the torpedo somewhere within five miles of its target (the closer the better), give it its orders, and get it started. In submarines, this is done by a blast of compressed air which pushes the baby vessel out of its tube. In the deck-tubes of surface vessels, a small explosive charge boosts the torpedo over the gunwales and into the water. Airplanes merely drop them.

When a torpedo is discharged, an amazing number of things begin to happen inside it, in an incredibly short time. A starting lever, tripped by the missile's forward movement, opens a valve, and a blast of compressed air starts the main engine. Another unit provides a highly inflammable fuel spray. Two slow-burning cartridges explode, go on burning like candles, to ignite this spray. In the same split-second an ingenious self-starting, self-regulating water-pot begins spraying water on the flame. Only a few feet away, remember, is 600 pounds of high explosive. The water-pot supplies water to make steam and, by regulating the volume of its spray, keeps the temperature in the fire-box exactly at 1250 degrees—no higher. The steam-gas-compressed-air mixture slams into the main engines with such force that 400 horsepower is instantly generated, quickly driving the torpedo's speed up to nearly a mile a minute.

Even more ingenious is the mechanism which guides the deadly "fish" on its swift little voyage. Just before it is launched, a torpedoman—on instruction from the fire control officer who has computed the position, speed, and range of the target—sets its direction and depth by adjusting a small, numbered spindle, like a radio dial. It is no longer necessary to aim the torpedo dead at its target. Whatever direction it may be launched, the mechanical "fish" will return to its set course before it settles down to its final straight run—a big help for the destroyer which does not want to turn its side toward the enemy and present a big target while firing its deck tubes.

The principal member of the torpedo's mechanical "crew" is a gyroscopic pilot. It is a bronze flywheel, the size of a teacup saucer, which is set whirling at 18,000 revolutions a minute by a jet of compressed air. Connected with this gyro-compass, and controlled by it, is a small engine, which operates the directional rudder. The gyroscopic pilot instantly corrects—through its engine and rudder—any deviation of the torpedo from this course. It never makes a mistake.

A torpedo must also hold to a second course, depth—usually about 15 feet below the surface. When hurled from a plane or a deck tube, it must not dive as deep as its immense weight inclines it to; it must not lunge out of the water like a tarpon on a line, or lose speed by gambolling up and down as torpedoes used to do. Its underwater course must be kept level. Another mechanical brain takes care of that. A sensitive pendulum and a hydrostat, which measures the depth of the torpedo by external water pressure, control a second small steering engine, which operates two horizontal rudders in the tail. If the torpedo is running closer to the surface or lower in the water than ordered, the rudders steer the "fish" down or up, until it is at the correct depth. All these mechanisms are fitted tidily within the torpedo's slim diameter—21 inches!

The "tin fish" used to leave a wide, tell-tale wake of lively white bubbles from the cold compressed air which streamed out its exhaust pipe. This sometimes gave the victim time to dodge the oncoming torpedo, and marked the position of the submarine which fired it. The modern torpedo leaves almost no wake. After the blazing, white-hot mixture of compressed air and steam has driven the torpedo's engine, it is exhausted through the hollow bronze propeller shaft. The steam, on striking the cold sea water, condenses, turns back into water; the hot air forms tiny slow-rising bubbles which cannot be seen from any distance. The "tin fish" is noisy, and can be picked up on sound-detecting devices, but seldom in time. It gives no warning and leaves no trace.

The deadly torpedo has already written a fearful record of destruction in World War II—the *Prince of Wales*, the *Repulse*, the *Bismark*, the *Ark*

Royal, the *Reuben James;* Taranto, Cape Matapan, Pearl Harbor; the Battle of the Atlantic, of the Mediterranean, of the Pacific. U-boat operations off our coasts indicate a new phase of torpedo warfare of unprecedented ferocity.

Before we entered the war, watchers reported that the big ship yards at Kiel, Bremen, and Hamburg had switched from big warships to small surface raiders and submarines. At Danzig and Stettin, large new submarine plants have been put up, and the torpedo school at Kiel has been enormously expanded. The United States Navy can play at that game too. Our own Torpedo Stations are humming as never before. Torpedoes used to be made almost exclusively in plants owned and operated by the Navy. Today scores of factories are working on confidential sub-contracts, turning out torpedo parts in an immense speed-up of their production.

The Battle of Macassar Straits has shown that we are as good at torpedoing as the Germans, if not better. The Japanese have learned that it is risky to move troops past the tubes of American torpedomen who traditionally pat their "tin fish" on the rump before they are loaded, care for them with the love of fine machinists for fine machinery, and dispatch them with an accuracy unparalleled by any other navy.

The decision in this next phase of the war lies in our ability to defeat the torpedo in the Atlantic, and win with it in the southern Pacific. The "tin fish" is still making history.

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SUCCESS

Workman's Suggestions Speed Production

How production of vital gunsight lamps has been increased by more than 2000 percent due to a factory worker's suggestions, is one of the many little "success" stories of the nation-wide national defense effort. The tiny lamp, about half the size of a walnut and used in delicate precision mechanisms for aiming big guns, was made entirely by hand only a few months ago; today, with the help of suggestions made by Matthew Westphal, a Westinghouse employee, it is machine made. As many as 2000 can be manufactured in a single day.

Mr. Westphal proposed a different type of stem and redesigned the mount for the filament. Due to his changes in the method of drawing air out of the bulb, it no longer has a pointed tip. Savings in material, labor and equipment have resulted from Mr. Westphal's suggestions. Valuable floor space formerly used by girls sitting at work benches is now available for other work. Girls have been released to do other important jobs. Only half as much glass tubing is needed in the lamp. Old equipment has been discarded and salvaged.

ALL-METAL YACHT

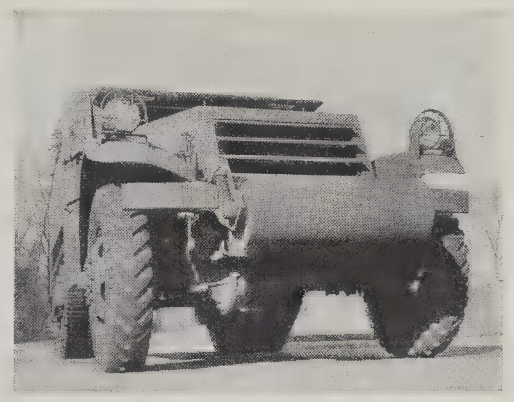
Will Be Used For Patrol Service

It has just been announced that the all-metal yacht "Revere," described on page 79 of the February 1942 issue of Scientific American, has been turned over to the United States Coast Guard for the duration of the war. The power and speed of this unusual water craft should make her particularly useful for waterway patrol service along the Florida coast, the work to which she will be put by the Coast Guard.

ROLLERS

Keep Reconnaissance Cars Out of Trouble

Reconnaissance cars are the advance scouts or feelers of the army and, as such, they must be versatile enough to cover all kinds of terrain. American-made units are not only the fastest of any comparable vehicles to be found in the world today, but they are built to travel over extremely

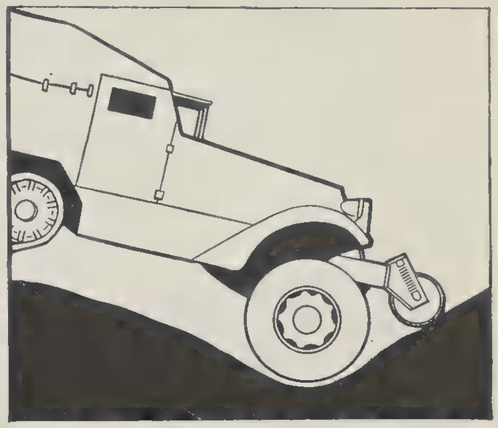


Mounted in front, like this . .

rough ground, not excluding trenches and shell holes. One of the features which permits this is the big forward roller—the guiding arm that lifts them out of difficult places.

The all-welded steel rollers on many of the military vehicles now being built by The White Motor Company and others have aroused considerable curiosity and comment among the general public. Many questions have been asked regarding their use, and the projected guesses have been both diversified and humorous.

Actually, the tough tubular rollers, four feet in length and 12 inches in diameter, have a definite and practical



. . it rolls the car up and out

use—to keep the vehicles from bogging down and to aid in pulling them out of the difficult spots. In short, these rollers afford the big lift to a machine in trouble. With their help, the Half-Tracs have climbed out of a 6-foot trench during testing operations.

The shell of the big steel roller is made of $\frac{1}{4}$-inch stock. Two reinforcement rings, as well as two bearing heads, are welded within at spaced positions. The need for great strength in the roller is recognized when one realizes the amount of weight and impact it must bear. Actually, the roller protrudes ahead of the bumper arm and thus takes the first shock when any forward contact is made. Then consider that the cars don't stop for bushes, small trees, fences and similar obstructions, and you can gain some idea of the impacts it must take. Add to this the lifting strength when half the weight of the vehicle may be imposed upon it going up a sharp incline. In order to be most effective, the roller has a spring mounting.

Success of the roller, of course, depends to a large extent on the traction power of the vehicle. The conventional scout cars, driving from all four wheels, can push up a 60 percent grade with a full complement of men. The Half-Trac, with its rear track system, exerts even more driving power and is well adapted to soft ground. When this modern reconnaissance unit pushes its front roller against a bank it gains the necessary lift to go on over.

These reconnaissance units are extremely maneuverable and are capable of traveling up to 50 miles an hour on highways or smooth ground. At the same time they can push over the roughest kind of country. The big steel roller in the front goes a long way in making this possible.

Glass Guns for Victory

Soil Testing in Gardens and on Farms Can Aid in Keeping Food Producing Machinery in Order

ARTHUR H. CARHART

In the enormous pattern of national effort, the growing of food crops on farms and in home gardens is of great importance. While our factories, mills, and mines pour out their war goods and raw materials, our good earth must go into full production to deliver a tremendous volume of food stuffs. While gasoline, coal, and electricity power the machines, food powers the men and women who run those machines.

The soil is thus a part of our national machinery for the production of war necessities. Food is as essential in war as guns and powder. The tremendous importance of this part of our war effort is indicated by the fact that, at a National Defense Gardening Conference held at Washington, D. C., last December, there was launched a Victory Garden Program. The national campaign to put the machinery of the soil into capacity production is under way. This is a war of science, and science will aid in garden and farm, just as in laboratory and factory.

The soil of our nation is one piece of defense machinery which may receive a hard and disastrous beating unless we give heed to putting it in top condition and keeping it so. Lowering of the production from our tilled soil may mean the difference between victory and defeat. With the crusade for total utilization of all tillable gardens and farms under full drive, the problem of keeping the soil in top condition and guarding against over-use and neglect must receive continuing attention.

Generally the soil is considered as a medium for growing things, without due recognition of the fact that it is a mechanism as definitely organized in its way as is the machinery within a factory. We plant seed, we water, we hoe weeds—and believe that nature will give us a good crop. Crop failure is often blamed on nature: but the real cause may be pure neglect of the soil machine.

No machine can be forced to produce to full capacity without proper maintenance. Parts wear. Essential cogs in the machine have to be replaced when they are worn. Just as certainly, forced production on tilled land produces wear and tear. Deficiencies occur in soil properties. Since the tilled land is a basic, indispensable part of the war production machinery, we must give it maintenance and replacements when needed, if it is to do its full part in bringing victory.

There are two objectives in such sound soil management as the Victory Garden Program will demand. The first is to bring the tilled ground to its fullest production as rapidly as possible. The second is to have that soil in as good condition at the end of the forced use as it was at the beginning of the drive. With correct management, the soil should not only be as good as it was at the start, but actually better.

Any program aimed at keeping field and garden soils in good condition has two sections. The first concerns the physical makeup. The most fertile soils often are those containing abundant organic matter. This humus is built up in the soil by turning under stubble in a field or spading leaf mold or similar material into the garden plot. Most tillers of the soil know of this need and will take care of it.

But it is the second and less easily determined procedure of keeping soil in first-grade condition that is likely to be overlooked. This involves the chemical constituents present or that must be added to the soil so that it will produce well and so that there will be no loss by excessive use, without replacement, of vital nutrients. This replacement is imperative if the soil is not to be worn out at the end of the forced production war effort.

There are four chemical factors in soil management or production processes that dominate the productivity of any tilled plot. First, there is the question of whether the soil is acid or alkaline. Some crops require one condition, some the other. To attain maximum production, the crop has to be fitted to the soil, or the soil to the crop. If the soil is acid, crops should be planted that will thrive in that condition of soil, or the reaction of the soil should be changed over to alkaline so that crops demanding that condition can be grown. The balancing of the acid-alkaline reaction is not difficult, but it is vital that this factor be known before a crop is planted.

The other three chemical factors involve the principal nutrients needed for maximum crop production. There are a number of plant food requirements in elements in the soil, but the three principal foods are nitrogen, phosphorous, and potash. And because these are the principal soil nutrients required by plants, they are the elements most heavily drawn from the soil in making growth and producing fruits and grains.

Just as milk cannot be drawn indefinitely from a cow without feeding good rations, so the soil cannot be

Soil sample is placed in test tube: testing kit with reagents at right

"milked" indefinitely without putting back some of the materials which roots must have in order to produce growth. High-pressure use of soil, where crops are forced for all they are worth, takes a heavy toll of these principal plant foods.

Furthermore, just as a dairy cow must have so much protein, so much carbohydrate, so much roughage, all in a balanced ration, in order to produce the maximum supply of milk, so plants feeding on a soil must have a "balanced ration." In other words, a soil that has adequate nitrogen and potash, but lacks a proper ratio of phosphorous, cannot supply a balanced ration to crops. It all goes back to the machine idea. If one of these elements is left out, an important cog in the crop-growing machine is not in gear.

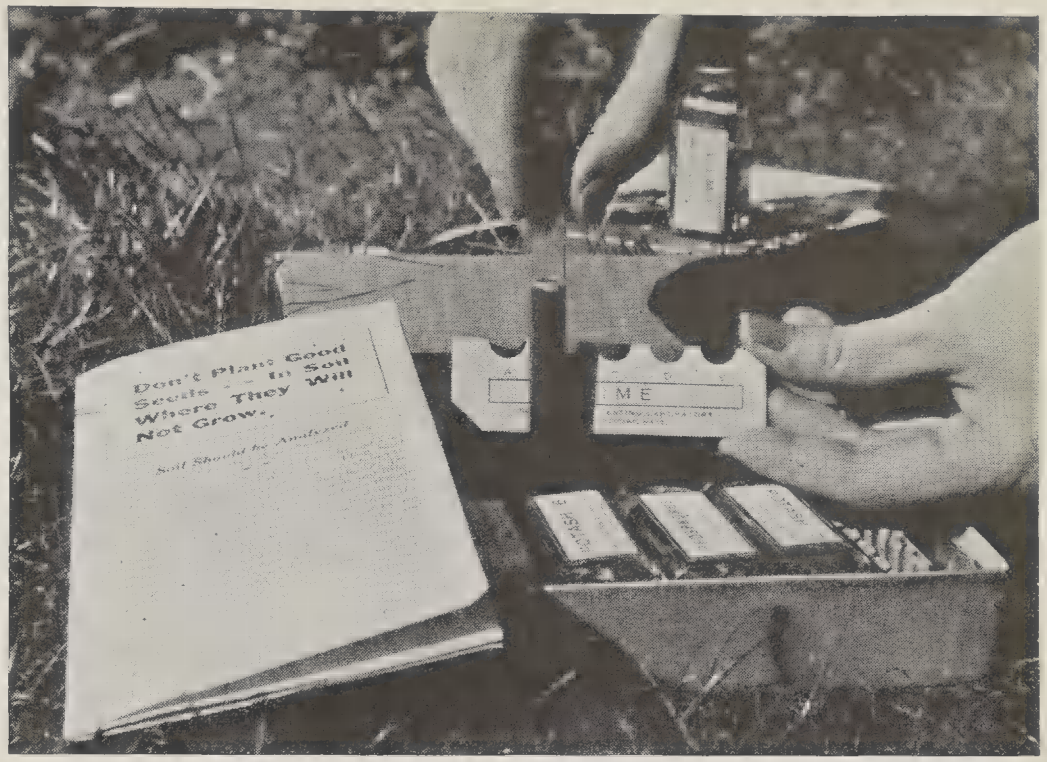
Of course, many farmers and gardeners are familiar with the general idea as it is presented here but it is a little too much to expect the average farmer or gardener to send soil samples every season, or twice a year, if that is better, to some laboratory; wait for the analysis to come back; and then add phosphorous or nitrogen or potash, or, if the soil is sour, to add lime. It's a lot of extra work. It may not show anything except that the soil is in fairly good shape, and the tendency all too often is to go ahead without analyzing the soil.

FARM and garden journals have been telling about these three most important soil elements for quite some time; state experimental stations have been sending out reports; speakers at short courses have discussed the subject quite fully. However, this has all seemed sort of visionary. The dirt farmer, the home gardener, did not have available, until recently, means of analyzing his soil without going to the trouble of sending samples to some distant laboratory.

Today there are soil test kits on the market so simplified that anyone who can read English, and is not color blind, can run his or her own soil test, not in hours, but in minutes and without complicated equipment.

The small soil test kits fit the pocket; others, slightly larger and a bit more accurate, can be carried in containers not unlike lunch boxes and really not much larger. The principal difference lies in the number of tests that can be made with either kit.

Here is how one learns whether the soil is acid or alkaline, what the nitrogen content may be, how much phosphorous is present, or whether or not potassium is lacking. Dig a soil sample out of the field with a common tablespoon, mixing several samples from different parts of the field if a composite test is desired. Put the soil in a glass test tube. (The spoon and test tube MUST be clean). Add the liquid for the desired test, such as for lime, potash, and so on. Shake. Each of the four tests has its own chemical reagent. The reaction of the soil with the solution poured on the soil sample gives a characteristic final color to the liquid.



Solution of soil and reagent, in test tube, is checked with color chart

In these kits are four color charts, one for each of the tests. Example: A soil sample has been put into a tube. The required reagent has been poured in. It has been shaken, and allowed to settle or has been filtered. Suppose it is a nitrogen test. Select the color chart which is marked nitrogen. Hold the tube up, hold the chart, and, by eye, make the nearest match between the tube color and chart color. Opposite the matched color on the chart is a capital letter. It may be "A" or anything on to "D". Having that, turn to the little printed manual that is part of the kit equipment. In that will be found the key letter of each test. The letter that designates the color on the chart, matched with the color in the glass tube, gives a direct answer.

That is the net process, for in the little booklet the key letter gives the answer as to how much of each nutrient is present in the soil. It tells how acid or alkaline the soil is in the alkaline-acid test, or how much or how little phosphorous, nitrogen, or potash there is in the soil.

If the soil needs the addition of phosphorous, the manual gives the approximate answer, not in technical terms, but in pounds per acre required to bring up that element to where it should be as a part of the machine to produce crops. It may save adding phosphorous when it is not needed, or upsetting the balance by adding a "complete fertilizer," which is a gunshot way of trying to bring the soil to high productivity, but actually may overbalance one food element already adequately present.

Whatever the primary or associated motives may be that prompt a grower to consider the production potentialities of his fields, every farmer and gardener now has, within reasonable reach, the means for putting the crop-growing machinery of the soil in condition to produce its best. The little glass test tubes and the liquids in glass bottles in a soil test kit are genuine weapons in your hands when you start to do your bit toward winning the war with your farm or garden. They are powerful glass guns for those who are getting ready to take their places in the ranks by enlisting in the Victory Garden Program for the duration.

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BREAD PROTECTION

By Addition of Mold-Inhibiting Agent

BY the simple addition to bread of a substance that is naturally present in many other foodstuffs, more than one and a half billion loaves of bread will be protected against mold in 1942, according to the du Pont Company.

Chemists say that the "mold inhibitor" has been proved to have such a

marked effect in delaying the growth of fungi in bread, that American bakers striving toward greater food conservation plan to extend its use by 10 to 15 percent during the coming year.

The lowest estimates of losses caused by mold growth on various foods run into millions of dollars annually. Now, with ever-increasing demands on the food supply, the elimination of as much of this loss as is possible becomes a national necessity, even though the rationing of food is not yet a probability.

Mold is believed to be caused by tiny spores of fungi in the air. Usually most active during the summer, these invisible particles develop in bread after baking. Their growth cannot be wholly eliminated even with the best sanitary precautions, air-conditioning, and ultra-violet lamp treatment, but it can be greatly retarded by the addition of the mold-inhibiting agent.

The agent is added to the bread dough before baking; it checks the development of mold particles in the loaf for a period of several days, thus allowing ample time for consumption of the loaf itself. A very small quantity of the mold inhibitor is sufficient for the protection of many loaves of bread, it is said; approximately two ounces of the agent will protect 100 loaves of bread. The agent does not affect either the taste or appearance of the bread.

MICROSCOPE

Identifies Compounds by Polarized Light

A VERSATILE and precise method for identifying organic chemical compounds promises to become a rapid and critical tool of chemical identification for these compounds. The method is one involving the use of polarized light transmitted through a microscope to determine the nature of an organic crystal. The physical principles are not new, but extensive work carried forward during the past decade has resulted in perfecting this system of analysis to the point where it may now be applied with confidence as a positive means of identification for a broad range of compounds.

In du Pont laboratories, a petrographic microscope is being employed that is similar to microscopes used to study the structure of rocks. Following accepted petrographic methods, colored interference patterns are created by passing polarized light through crystals of organic compounds, and these patterns are then compared with known standards to determine the exact compounds being analyzed. Use of light of various colors is an essential feature of the methods.

Although comparatively expensive equipment and considerable experience are essential to an identification of this type, it is said that once these are available, the method can be applied practically to all organic compounds, whether gases or liquids, provided that they can be converted to crystalline derivatives for observation. Only very small amounts of material are required.

The method is reported to be "able to stand on its own feet as a technique of identification, and offers considerable time-saving possibilities in distinguishing between compounds having chemical features in common."

PSYCHIC RESEARCH

● Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. Further reports of The Scientific American Committee for the Investigation of Psychic Phenomena will be published in forthcoming issues. ●

GLUE . . . OR GLUE

When Is Plastic A Glue?

WITH plywood reaching a position of increased importance in industrial applications, there has arisen a confusion of terms as applied to those materials which are used to fabricate the finished plywood from thin strips of veneer. In this connection a letter recently addressed to the editor by Mr. J. F. Laucks, President of I. F. Laucks, Inc., Manufacturing Chemists, holds considerable interest. The following paragraphs, quoted from Mr. Laucks' letter, clarifies the situation:

"I believe it is time to call a glue pot a glue pot. As a glue manufacturer I am getting tired of hearing glued-up articles being referred to as 'plastics' either because of lack of comprehension of the difference between the plastic art and the glue art or because of some misguided notion that glue is not a subject of polite conversation.

"For some time back now I have been reading articles in the press, in the magazines, in the trade papers and technical journals about *plastic* airplanes, but I submit that these are nothing more or less than glued-up plywood formed into the proper shapes. A plain piece of plywood might just as well be called a plastic.

"Just the other day I saw in one of the nation's prominent newspapers a statement about plywood which ended: 'The old art of using glue has been supplanted.' This was the final straw.

"That there is a great difference between the gluing and plastic processes is commonplace knowledge to anybody who knows very much about either. I personally have good authority on which to base a statement about this difference. I once had to fight a patent suit in which my opponents claimed that there is no distinction between

Petrographic microscope. *Left insert:* Crystal of organic compound. *Right:* Optical picture created in microscope by polarized light through crystal

the plastic art and the glue art. After hearing testimony for two years, the court decided that these are two separate and distinct arts. This decision should carry some weight. If the Patent Office considers these arts dissimilar, and in practice they are entirely different, I think the general public should recognize the fact.

"Perhaps the present prevalent habit of calling everything a plastic that can be remotely included in that category is due as much to the fact that plastics are currently fashionable as from a general disinclination to use the word 'glue.' Plastics, of course, are new. The art of gluing, on the other hand, dates from at least early Egyptian times.

"Gluing might be defined as the art of binding two pieces of wood together to make a joint that is stronger than the wood itself. In this definition I do not state what the binding means are. The ancient glues were made of either bones, hoofs, and hides (whence I suppose the name glue first acquired a bad odor) or of casein. Later came starch glues which do not smell bad, still later came soybean glues which do not smell bad, and later yet came synthetic resins, some of which do and some of which do not smell bad. Now then, just because some glues smell bad, should the entire glue industry be made to feel that it ought to apologize for itself? Should the people who use our product do so on the sly and cover up this fact by declaring they are making plastics?

"I maintain that the art of making a joint stronger than the wood is a real art and an honorable one. It is the art of gluing, and neither the man who knows how to do it nor the man who knows how to make a glue to do it with need be ashamed of saying they are in the glue business or that they are using glue. I insist that the old art of using glue has *not* been supplanted but instead is expanding its uses into ever wider fields and is becoming of progressively greater importance every day."

GREEN BLUSH

When Euglena Blushes, Pigments Shift

How *Euglena rubra*, a species of microscopic freshwater animal, reacts to lowered temperatures by changing its color from red to green and taking on the characteristics of a plant, was disclosed in a recent issue of *Physiological Zoology*. Writing on the "Cause of the Green-Red Color Change in *Euglena Rubra*," Drs. L. P. Johnson, of Drake University, and Theodore L. Jahn, of the University of Iowa, revealed that the curious change of color which occurs when the animals are subjected to changing temperatures is due to the migration of red pigments from one part of the body to another.

Specimens of *Euglena rubra* were obtained from a small pond in Iowa, where they formed a bright red scum on the surface of the water. When the temperature of the animals was lowered to below 86 degrees, Fahrenheit, the red pigment near the surface of the cell migrated toward the center of the body, leaving chlorophyll at the surface, which gave the animal a green color. The red color was restored by heating, or by subjecting the animals to infra-red rays, artificial light, or sunlight.

Pure water, safe for drinking, from Los Angeles River, by "Sterozone"

PURE WATER

Produced by Portable Ozone Generator

A completely automatic, self-contained water purification plant that literally burns bacteria out of water has been developed for use in army camps and by troops on maneuvers, but has industrial and municipal applications as well. The "Sterozone" unit, as the plant has been named, has a rated capacity up to 9000 gallons per hour; automatic parallel operation of units can be made to supply larger requirements.

Raw water is pumped from the source through a filter to remove suspended matter and then passed to an absorber chamber where ozone, generated by a high-frequency silent electric discharge, oxidizes the bacterial contamination and delivers pure, sparkling, fresh water that has no taste or odor. Unlike water that is disinfected by the addition of chlorine, there is no danger of overtreatment which may result in an unpleasant taste that may force troops to prefer untreated, contaminated water.

Power for the plant is supplied from an automatic gasoline-engine driven 10 KVA., 220-volt, 3-phase power plant. This unit is self-starting and self-regulating. The only attention required is lubrication and fueling. All mechanism is driven by a five-horsepower, 220-volt, 3-phase electric motor on which is direct mounted the treated water supply pump and coupling. Connected to the other end is the raw water supply pump. Also driven from the motor shaft are the compressor, cooling water circulating pump, and the evaporative cooler.

Ozone is generated by the silent blue electric discharge between aluminum plates maintained at 13,000 volts by a 2.0 KVA transformer. Ozonized air is injected directly into the absorber through which it flows counter-current to the water in four separate stages. Diffusion, injection, turbulation, and scrubbing obtain efficient absorption of the ozone.

[For a more comprehensive discussion of the principles involved in water sterilization with ozone, the reader is referred to page 136, March 1942 Scientific American.—*The Editor*.]

DRY ROT

Occurs Only When Moisture Is Present

There is no real "dry rot" that attacks wood and causes it to decay. Wood must contain more than 20 percent of moisture before fungi can grow in it. What is ordinarily called "dry rot" is caused by one of a few species of

fungi that grow rootlike strands that serve as pipelines through which they draw into dry wood the water they must have to live and to destroy the wood. These rootlike strands must reach moist soil or some other source of moisture if the "dry rot" is to cause decay of the wood, say United States Department of Agriculture scientists who have studied the various forms of wood destruction.

Wood kept dry, they emphasize, is a permanent building material. One way to prevent decay of wood is to inject into it preservative chemicals that prevent fungus growth. The other way is to keep it dry so that fungi can not live. Even the "dry rot" fungi can not develop if water can be kept beyond their reach.

SULFA-DOG

The Sulfa Drugs Also Work Wonders in Canine Cures

THE big five in chemo-therapy—sulfapyridine, sulfanilamide, sulfathiazole, sulfadiazine, and sulfaguanidine—are proving to be valuable drugs in veterinary practice, according to Dr. Arthur Bryan, Baltimore veterinarian.

In compound fractures, no matter how serious the wound or the possibility of sepsis, sulfoamide powder can be dusted into the wound and healing occurs without infection or even wound fever. Peritonitis may be entirely prevented in small animals by implanting powdered sulfa drugs as a post-operative procedure. In fact, infections of all kinds in our domestic animals appear to be more or less doomed to extinction, if the new sulfa drugs are used in time. Infections of the eye and ear respond promptly to sulfapyridine, sulfadiazine, or sulfathiazole, when these powdered drugs are worked directly into the infected region. Summer diarrhea and dangerous food poisoning infections, particularly of small animals, respond to the recently developed drug, sulfaguanidine, which has a selective action on the intestinal tract.

These sulfoamide drugs, while performing modern veterinary medical miracles, are toxic and dangerous in the hands of the laity, and the up-to-date veterinarian alone is competent to prescribe these drugs for the benefit of our animal population.

FISH

And Their Reaction To Air Raids

MEMBERS of angling clubs in various parts of Britain, where heavy air raids have been experienced, report that fish bite much better on the day following a severe blitz in the district. It is believed that the loud noises caused by exploding bombs, gun-fire, and so on have the same effect on fish as thunder. A bad thunder-storm always upsets fish and prevents them from feeding and consequently they are apt to feed voraciously when the disturbance is over.

DECALCOMANIAS

For Chinaware Made by Photographic Process

A NEW process for making chinaware decalcomanias, which substitutes photo-lithography for hand-lithography in preparing plates from which decalcomanias are printed, makes possible exact and yet rapid reproduction of artists' designs. American independence in chinaware decalcomanias is expected when volume production by this method is attained. Seventy percent of the decalcomanias used by American chinaware manufacturers were imported at the start of the war. An increasing scarcity of decalcomanias helped create unprecedented backlogs in chinaware orders.

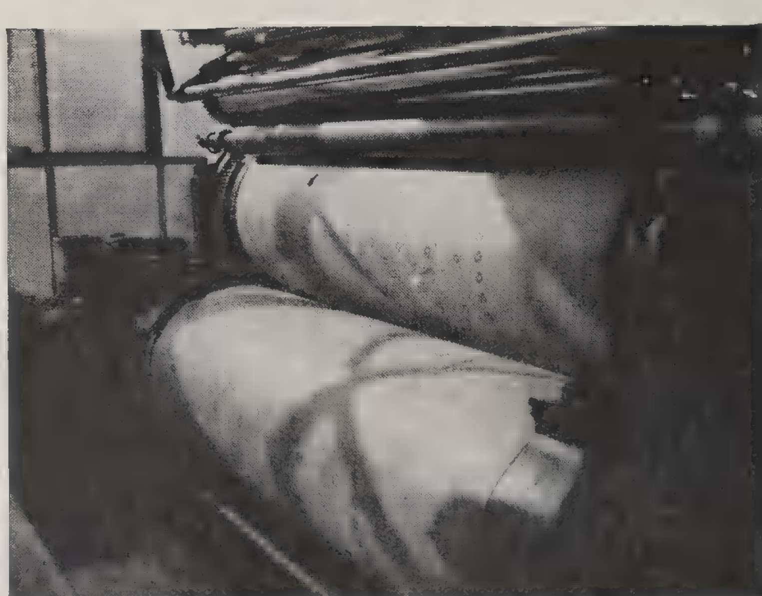
In the new process, artists' designs are photographed through color filters and reproduced on sensitized metal plates, instead of being tediously stippled by skilled craftsmen on soft stone. The designs are then transferred by use of a special offset lithograph press.

It is pointed out that a more beautiful chinaware will be available in all price ranges because photo-lithography can reproduce not only more intricate designs but do so with finer gradations of shading and blending of colors. The color shade of one plate is said to achieve an effect which formerly required three shades of one color, or three different stone plates.

In transferring an artist's design to a stone plate, the craftsman stipples a maze of tiny dots with stippling pens. However, even the most skilled workmen are unable to stipple all the fine dots necessary to copying the design exactly. By contrast, the sensitive photograph plate misses nothing because it actually reproduces the design itself.

The artist's work is photographed through color filters for each color in the sketch. The camera detects and reproduces every detail and vestige of a particular color in the design, though it may not be visible to the naked eye. From each negative a positive is developed, and from that positive is made a sensitized metal plate for the offset lithograph press. The plates, incidentally, may be reused by etching off and regraining.

Petit point decalcomania patterns—which American manufacturers formerly considered very difficult and have been hesitant in supplying—are now being reproduced on dinnerware by photo-lithography. On imported ware, such designs are completed by hand in order to obtain the delicate



Left: **Photographing an artist's design for decalcomania use.** *Right:* **Printing decals on high-speed press**

effect of many-colored needlework. The new domestic process eliminates the need of this supplementary touching up, as the camera exactly reproduces the intricate pattern and fine shadings of the artist's sketch.

Black and brown etchings of historic shrines and other scenic designs can be copied for the decoration of service plates with no loss of artistic quality. Pictorial designs transferred by the hand-lithograph process appear faded in comparison. Photo-lithography assures not only complete color control for decalcomania patterns but also combinations of line and half-tone which are beyond the scope of the hand method.

Research work on this new process of producing decalcomanias has been conducted by the Ceramic Products Division of the du Pont's R. & H. Chemicals Department, long experienced in manufacturing ceramic colors. After many months of work, a satisfactory process was developed and installed on a semi-works scale at a lithograph plant in New Jersey. These superior decalcomanias made by the new process found ready acceptance by chinaware manufacturers. Demand exceeded supply of decalcomanias from the start, and there is still no indication when equipment will be available to make decalcomanias sufficient to meet demand.

SOY BEANS

Uses Have Been Widely Developed by Research

The Jack-and-the Beanstalk growth of the soybean crop and the soybean products industry in the United States has not been a fortunate accident. Instead, "it has been made possible through the results of research" by government agencies and by the industry, according to T. H. Hopper of the United States Department of Agriculture.

Some of the steps in this "phenomenal development," which has added a major crop to American agriculture, and two items already important in commerce—soybean oil and soybean oil meal—are the following: Improved varieties have been selected and bred from foreign seed; utility and climatic adaptations of superior varieties have been improved and farmers have learned to grow the crop; industrial equipment has been developed and greatly improved; the chemistry and physics of soybean oil have been investigated, and methods of refining and improving it for various uses have been studied, and the amount of the meal now used for the manufacture of adhesives and plastics may very materially increase; systematic marketing of soybeans has been instituted; official grade standards have been developed. As a result of this work soybeans have become one of the commodity items of futures trading.

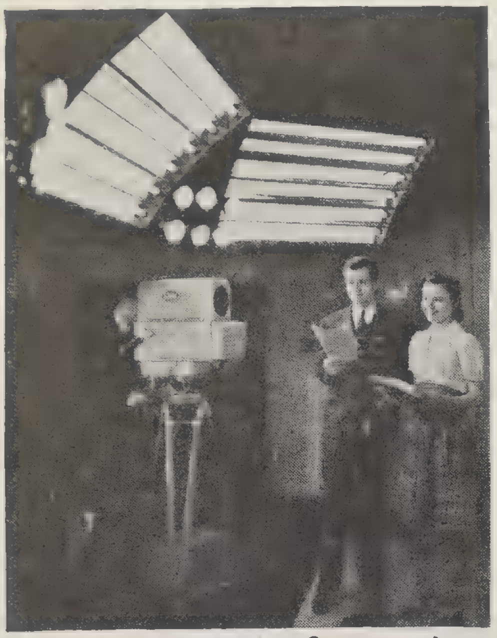
TELEVISION LIGHT

Supplemented With Fluorescent Tubes

Even with the increased efficiency of television transmitting equipment which has been brought about in recent years, studio designers still are faced with problems of heat generated by the high-intensity light sources required for satisfactory television pick up.

As a new attack on this problem, Westinghouse engineers have recently installed in the Dumont experimental television studios in New York City a lighting system which combines both incandescent and fluorescent lamps. In this installation, 95 percent of the heat felt by the actors is generated by the filament lamps. Performers are normally placed about 10 feet from the lights, which consist of 12 300-watt incandescent spots and 12 40-watt

fluorescent tubes. The fluorescent lamps alone supply approximately 300 footcandles, the reflector spots being used to bring local lighting levels up to 1000 footcandles. The 480 watts of fluorescent lighting provide approximately 20,000 lumens of light, the 3600 watts of incandescent about 30,000 lumens. If incandescent lights alone were used, another 1500 watts or



Incandescent plus fluorescent

more would be required to provide the same number of lumens of light on the performers. This, of course, would result in greatly increased heat.

In the experimental set-up shown in one of our photographs, the filament lamps are used only during actual broadcasting. Rehearsals and preliminary work prior to going on the air are done under the fluorescent lamps alone.

FINGER-SIZED

Small Fluorescents Require High Voltages

How fluorescent lamps may be stretched into long ribbons like neon sign tubing, was described recently by Dr. J. W. Marden and George Meister of the Westinghouse Lamp Research Laboratories. In their report presented before the Illuminated Engineering Society it was indicated that finger-sized fluorescent lamps must be a "high-voltage" type as compared with the 10,000,000 low-voltage fluorescent lamps now in use throughout the United States. High-voltage lamps were defined as operating at several hundred or more volts.

The research scientists explained that the biggest fluorescent lamp now manufactured is five feet long, 2¼ inches in diameter, and consumes 100 watts at line voltages. A 100-watt tube one-half inch in diameter would have to be 24 feet long and would need 2000 volts to supply as much light as the five-foot giant.

In discussing the practicability of high-voltage fluorescent lamps, Dr. Marden and Mr. Meister agreed that they would undoubtedly be used sparingly where high levels of lighting are required, because the amount of light per foot is low in comparison with orthodox lamps. In coves, however, and in places where concealed lighting may be wanted and low levels of illumination are satisfactory, they might have considerable utility.

AIR ARCHEOLOGY

War Fails to Stop British Archeologists

In the thick of the Battle of Britain, flying archeologist O. G. S. Crawford, by arrangement with the Air Ministry, undertook an aerial survey of ancient buried ruins of the Roman city of Verulamium near St. Albans.

Prolonged drought had scorched grass growing over part of the Roman city, causing brown streaks to form with unusual plainness on tennis courts and cricket grounds there. These streaks reveal a chess-board plan of the buried Roman city, its streets and buildings. Photographed from 3000 feet, the scorched field has added new features to archeological knowledge of one of ancient Britain's outstanding cities.

A widening of the ancient east-west road of the city formed what may have been a parking area of the 2nd Century A.D., Philip Corder, curator of the Verulamium Museum, reports in the British Journal, *Archeology*, from study of the air views, according to *Science Service*. The plan of a small Romano-Celtic temple and evidence of many other buildings are disclosed.

GLACIERS

Of Comparatively Recent Origin

Glaciers in the Sierra Nevada mountains are recent in origin and are not relics of the Great Ice Age as tourists are frequently told by guides, according to Dr. Francois E. Matthes, of the United States Geological Survey.

"The small glaciers of the Sierra Nevada are commonly believed to be shrunken remnants of the large glaciers of the Great Ice Age," Dr. Matthes says. "However, facts indicate that these glaciers have been in existence but a short time and are successors to, rather than remnants of, the Ice Age glaciers. They probably originated at about the same time as Owens Lake, which is fed by the snows of the Sierra Nevada. From its salt content, the age of the lake can be estimated as less than four thousand years.

"The lake and glaciers therefore may have been created with the advent of the present relatively cool and moist conditions which followed the Ice Age. It is probable that they made their last advances in the 17th, 18th, and 19th Centuries, and that the glacial deposits in the region date from the last great advance in about 1850."

Evidence of the youth of the Sierra Nevada glaciers is seen in the relatively small bulk of the material deposited by them, Dr. Matthes declares. This material could not represent an accumulation of ten thousand years, the time that has elapsed since the Ice Age.

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STERILIZER—Equipment used for canning salmon at Ketchikan, Alaska, is being used for packaging first aid kits. The kits are delivered by the machine sealed and sterilized.

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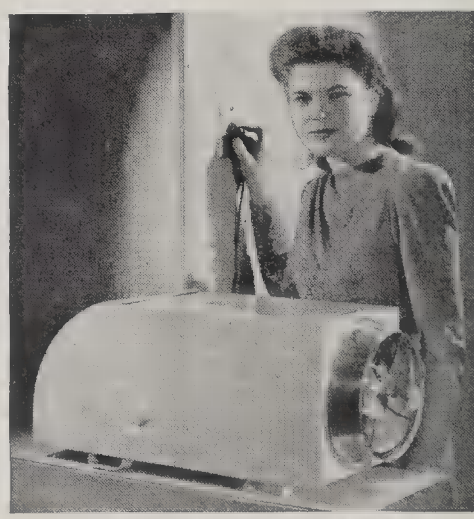
DEODORIZER

Of New Design, For Home, Office

Four cannisters filled with activated carbon, a dust filter, and a circulating fan operated by a 40-watt motor are the essential parts of a newly designed odor adsorber recently announced by W. B. Conner Engineering Corporation. This unit, enclosed in a metal cabinet, is intended for use in homes, offices, hospital rooms, and so on where



Carbon does the trick

the air is sometimes contaminated by odors or certain gases.

In operation, the contaminated air is drawn into the Dorex Odor Adsorber, as the unit is called, by means of a fan. It is then drawn through the dust filter and then through the acti-

vated coconut-shell carbon before being returned to the room. The carbon adsorbs the odors or gas in the air so that all the impurities remain in the unit and only clean, odor-free air is discharged. The carbon can be reactivated, upon saturation, and used over and over again. The air handling capacity of the unit illustrated in these columns is approximately 100 cubic feet per minute.

SKULL CUPS

Odd Drinking Vessels Used in America

Some of the earliest Americans made drinking cups of human skulls, according to Dr. Ales Hrdlicka, Curator of Physical Anthropology of the Smithsonian Institution, who found new examples of this macaber practice in village sites on Kodiak Island.

The Kodiak Islanders whose remains were studied were among the first migrants from Siberia to settle on the North American continent. They were cannibals, so there was no shortage of skulls from which to make the cups.

The practice, it is believed, was not solely utilitarian. The Pre-Koniags, as Dr. Hrdlicka calls the long-vanished people, may have used skulls of valorous enemies for cups in the belief that some of the virtues of the former owner would be transmitted to the beverage.

At one time, Dr. Hrdlicka says, the practice was widely distributed over the world and dates back at least to the late Stone Age in Europe. In America it can be traced over both continents. The Araucanians of Chile honored some of the slain leaders of Spanish expeditions against them by converting their skulls into bowls.

EARLY SMOKING

Use of Pipes Dated to 5th Century

The American Indians introduced the use of tobacco to early European explorers, but who introduced it to the Indians? This question is probably unanswerable, but evidence of the earliest known smoking of pipes, dated at some 1500 years ago, has been found by the Field Museum Archeological Expedition to the Southwest. The fuel may have been tobacco, or may have been oak leaves, grasses, or something else.

This is one of the discoveries reported by Dr. Paul S. Martin, chief curator of anthropology at Field Museum of Natural History, and leader of the expedition, upon his return from a prehistoric site which he and associate archeologists have been excavating in New Mexico.

The ancient village which the expedition brought to light, in the ruins of which a number of pipes were found, is estimated to have flourished about the 5th Century A.D., or approximately a thousand years before the first white man invaded America and learned about smoking. Members of all tribes of Indians in the area from the Great Lakes to Argentina have had the smoking habit for centuries, says Dr. Martin, but the people who inhabited the village he has unearthed may have been the very first to indulge.

MOTOR MOLES

Cars Operate Under Ideal Conditions

Down under Detroit, two topless roadsters without license plates roll over 22 miles of roadways many times daily. They travel in weather always dry and clear, climb no hills, halt for no traffic lights.

These roadsters are the foreman's car and the service car for a rambling,

160-acre salt mine 1100 feet under Detroit. The city traffic rumbles on above, neither affecting nor affected by the mine beneath it. The mine also has many miles of narrow-gage railroad and electric locomotives moving trains of cars loaded with lumps of blasted-out salt to the crushers, graders, and sorters. It also has an office and even a machine shop to keep the machinery in order. Getting the roadsters into the mine was a problem. They wouldn't fit into the elevator with the tops on. Since there was neither rain nor sun, nor snow, nor hail in the mine, the tops were removed and the cars were lowered into the shaft.

TARTARIC ACID

From Corn Becomes A Possibility

With imports of tartaric acid cut sharply by war, and with its price increased nearly 150 percent, the United States Department of Agriculture is watching the results of research that indicate the possibility of converting corn into tartaric acid.

Dr. O. E. May, Director of the Northern Regional Research Laboratory at Peoria, Illinois, has reported that research workers of the Laboratory have developed an efficient and cheap means of producing from corn sugar an intermediate product, 5-keto-gluconic acid, from which tartaric acid may be synthesized. The method worked out on a laboratory scale will be tested in pilot plant equipment. The United States has a plentiful supply of corn sugar or glucose.

• • •

PORCELAIN — Defense-needed plastics, aluminum, and hard rubber are being replaced in many cases by a new type of porcelain developed by Westinghouse.

• • •

CORROSION

Resisted By Powder For Damaged Tin Surfaces

When tin surfaces have been damaged by handling, or worn away through use, or burned away in welding, the defective area can be repaired with a new metallic coating powder made by American Solder & Flux. The repair material, however, is not intended for use in containers that come in direct contact with food.

In use, the metallic powder is placed on the area to be repaired and heat is applied. Since the powder has a lower melting point than tin, the heat used for melting it does not disturb the original surface. It is stated that a surface repaired with this powder is rust and corrosion resistant and resembles a tinned surface in appearance.

MATCH SOLDERING

Made Possible With New Units

Strong, perfectly soldered electrical connections can be obtained without the use of the conventional soldering iron or torch, through the medium of "Jiggers." Each Jigger is a small self-contained soldering unit consisting of the correct amount of 50-50 solder and flux hermetically sealed within a waterproof heat-generating outer shell.

The sequence of operations in using these soldering units is shown in one of our illustrations. The wire splice is pushed into a Jigger and a lighted match is applied to the outer shell. The shell ignites and produces the correct temperature to flow the solder into the splice. The burned shell is then dropped off, leaving a clean soldered splice.

Slip it on twisted wires, ignite with match: Soldered joint results

PEAT

Brown Gold Of Alaska Muskegs

Alaska has a virtually untouched "Klondike" in its 110 million acres of peat muskegs—if anyone can develop satisfactory and inexpensive ways of packing and transporting the peat. Farmers and gardeners use commercial peat to supply soil humus. They also use peat for bedding in stables and as poultry litter that, in turn, becomes valuable manure. Several kinds of peat make good composts when combined with waste materials. Alaska fertilizer supplies also include fish-canning wastes.

The United States Department of Agriculture recently concluded a preliminary survey of the peat resources of Alaska, with a view to possible encouragement of a small-scale peat industry. Many muskegs are accessible from the coast.

The survey revealed sphagnum moss peats and sedge peats, both desirable for improving soils and for other agricultural uses. Through ages, this peat has accumulated on the surface and now forms layers from four to six or more feet deep. Only simple tools are needed to dig the peat. The surveyors made no exact estimates of supplies, but the reserves are ample.

Chief obstacles to marketing Alaskan peat are the short summer season, sparse labor supply, and transportation problems. Local plants could dry, shred, and pack the peat, but economic studies will be needed before the Department can recommend development of an Alaskan peat industry.

POWER ALCOHOL

Not Yet Feasible or Necessary in United States

Periodically there crops up a discussion regarding the use of alcohol as a motor fuel in the United States. Sometimes this discussion is motivated by a desire to conserve fuel obtained from petroleum and sometimes by a desire to create more extensive outlets for agricultural products. It is known, of course, that power alcohol is being widely used abroad and hence would seem to be a logical development in this country.

Because of the uncertainty of the exact status of power alcohol, from the standpoint of both technology and economy, it is interesting to note a part of a letter recently addressed by President Roosevelt to Honorable Gordon H. Garland, Speaker of the Assembly, California Legislator. This letter was in answer to a communication from The Honorable Mr. Garland regarding a joint resolution urging the establishment of plants for the conversion of surplus fruit and vegetables into alcohol for use in national defense as an auxiliary fuel.

"While it is true," stated the President, "that a number of foreign countries process agricultural materials for the production of alcohol as a motor fuel, it is equally true that the motor fuel economy of countries possessing no petroleum resources is very different from such economy in the United States. It has never been established in this country that the conversion of agricultural products into motor fuel is economically feasible or necessary for national defense.

"On the other hand, it has been recognized for some time that a real need exists in this country for the development of all the information possible on this very contentious subject. Hence a pilot-plant is being set up at the Northern Regional Research Laboratory of

the Department of Agriculture at Peoria, Illinois, to make such studies. Until this plant is completed and has been in operation on a variety of agricultural products for such time as may be required for the collection of essential data, it would not seem advisable to undertake the project advanced in Assembly Joint Resolution Number 21."

FIRE-SAFE

Air-Conditioning System Fire Yields Lessons

Fire-safe air-conditioning equipment is of primary importance to public buildings and stores where large numbers of people congregate. For this reason a fire which originated in the air-conditioning system of a Toledo, Ohio, department store has been carefully studied with a view to determining measures to safeguard against similar occurrences in the future.

The Toledo fire occurred in a four-story and basement structure, starting in the room housing the air-conditioning equipment. First indication of fire was smoke issuing from a louvre in the wall of this room. Then haze poured out of the air-conditioning ducts. The manual controls for the louvre openings and the control switch for the air-conditioning system were located in the air-conditioning room. Fortunately, an engineer was able to work his way into the room housing the equipment and pull the control switch just before the sprinkler heads operated and extinguished the fire.

The only direct fire damage was to the interior of the air-conditioning room and its equipment. Damage by smoke to merchandise was remarkably small, apparently because some of the particles were removed from the smoke by the fiber-glass filters of the air-conditioning system. These filters, coated with a non-flammable dust-holding oil, also acted as a fire barrier to prevent spread of fire through the ducts.

It is apparent that the fire actually started in an accumulation of flammable material which may have been drawn into the air-conditioning room through the return louvres located at floor level. Since the fire these louvres have been relocated seven feet above the floor. Also, the louvre and motor controls have been removed to the outside of the air-conditioning room where they can be more easily reached.

This fire clearly shows that the important factors to be considered in installing air-conditioning equipment are as follows: Automatic dampers should be provided on both sides of filter chambers; fine screening should be placed in all return ducts or louvre openings to

prevent flammable material from entering; air filters should be of a type that will not burn; horizontal ducts should have a number of door openings for ease of cleaning; remote control at an easily accessible point should be provided for louvres and motors; all portions of the room housing the air-conditioning apparatus should be equipped with sprinklers.

BLACKOUT BULB

Yields Blue Light, Directed Downward

Designed for blackout lighting in air raids, a new blackout bulb provides downlighting in a soft beam of blue light that is safe for indoor visibility during blackouts. The bulb, just announced by the Wabash Appliance Corporation, is lined inside with a silver reflector lining that hides all filament glare and projects the light downward. Light leaks are prevented by a black silicate coating that covers the bulb up to the extreme lighting end, which is a deep blue.

Blue light for blackouts

FLAMEPROOFING

Made Possible By Laboratory Curiosity

Every minute and a half—on the average—a home catches fire somewhere in the United States. Blazes often start from fireplace sparks. Sometimes a flimsy window curtain blows over a gas range burner. Smoking in bed is a common dangerous practice. And children still play with matches.

From now on, such fires need never happen. Thanks to chemical research, all the flammable fabrics in the home may be "flameproofed" simply and effectively. With many of them, it's as easy as starching on wash day.

Annually, some 8700 fatalities from burns are listed, along with countless injuries. Many of these are attributable to clothing that caught fire.

A great decrease in such accidents is foreseeable by "flameproofing" our clothing. The sheerest negligee, a velvet evening gown, the arc-welder's overalls, the little girl's frilly party frock, all may be treated by dipping or spraying with the chemical so that, though they may char upon contact with flame, they will not flame or support combustion.

Fabrics immersed in a solution of one pound of the new fire retardant, ammonium sulfamate, to one gallon of water, and then dried, will remain incapable of supporting fire until washed, when the treatment is repeated. Dry-cleaning does not remove the fire protection quality or appreciably impair it.

Moreover, this chemical newcomer, first announced on page 140, March 1942 Scientific American, is said to be unique because it does not affect the "feel" or appearance of fabrics. Indeed, it takes an expert—or a flame—to distinguish between treated and untreated goods.

Until three years ago, sulfamic acid, the crystalline powder from which the ammonia salt for flameproofing is made, was a laboratory curiosity. All known methods of producing it were prohibitively costly, and had always been since the acid was first tediously prepared by the Swedish chemist Berglund 63 years ago.

Then, in 1939, at the Experimental Station of the Du Pont Company, an economical way of making sulfamic acid was developed. At that time scarcely a single practical use was known for the acid.

But a few weeks ago a plant to manufacture the new industrial chemical by the tons was opened. It is the first and only plant of its kind in the world. The reason for it being built is that sulfamic acid and its derivatives are now known to be useful for more than a dozen important purposes, ranging from leather tanning and dyeing processes to killing poison ivy and ragweed—and now flameproofing textiles.

Because it affords such a high degree of protection against flame and flying sparks, the fire retardant has for some months been used in airplane manufacture, in workmen's clothing in steel mills and in shipyards. A disastrous fire in the chemical laboratory of a large university recently led to the flameproofing of students' "lab" smocks.

Of particular importance, safety engineers point out, is the flameproofing of pile fabrics. These are prone to "flash" burn—that is, flame will liter-

ally sweep across the nap in an instant.

Broad usage of the fire retardant is fairly certain to open up in two other fields where safety is an urgent need. One is in paper, especially for decorative purposes. The other adaptation lies in treatment of insulating materials to prevent the spread of flames in frame dwellings.

Some progressive dry-cleaners and laundrymen already are offering customers a fire retardant treatment for clothing, bed-sheets, blankets and the like. It is predicted that textile mills will shortly begin flameproofing fabrics in course of manufacture.

FOREST FIRES

Greatly Reduced in Protected Areas

THE forest lands of the United States are now better defended against fire than ever before, according to the United States Department of Agriculture. Vast strides have been made in the increase of forest area being given fire protection and in the fire control methods and equipment being used.

In addition, the Forest Service points out, fire lookout towers and both federal and state lookout stations are available, if needed, in the present war for use as air-raid spotting stations and detection of possible enemy signal fires or incendiary sabotage. These mountain stations, once vulnerable to telephone-line service troubles, are now made much less so through the adoption of shortwave radios by the Forest Service.

Like modern armies, up-to-date fire control organizations have been mechanized. Portable power water pumps have replaced the 10-quart pail and, whenever practicable, handtool fire line construction is supplemented with the use of portable power-driven equipment. Airplane transportation of supplies, equipment, and manpower to inaccessible fires where delivery is made by parachute, now regular procedure, is a practice unknown during the last war.

A little more than 11 million dollars in funds will be available for this forest fire protection during the 1942 fire season. The Department's foresters estimate that an additional six million dollars would be required to protect all forest lands needing it. A total of 146,000,000 acres of forest land in the United States still lack any organized fire protection, according to the Forest Service. The unprotected area amounts to about one-quarter of all the country's forest lands needing protection.

Fires on unprotected forest lands accounted for 87 percent of all the area burned over in the United States last year.

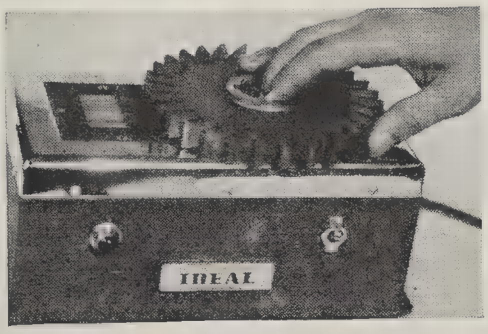
Industrial Growth

New Products and Processes That Reflect Applications of Research to Industrial Production

DEMAGNETIZER

For Equipment Used In Production

When tools, drills, punches, and other machine shop equipment and work pieces become magnetized, as they do when being used with magnetic chucks, they are bound to attract small and sometimes almost invisible chips and dust. These particles, clinging to the magnetized cutting edge of a tool, act as an abrasive between the tool and the work, causing the tool to bind or heat and dull quickly.



Prevents metal pick-up

Such magnetized machine shop equipment can be quickly demagnetized with a powerful, portable demagnetizer recently announced by the Ideal Commutator Dresser Company. The tool or work is merely passed across the magnetic poles of the unit or, in the case of large parts, the magnetizer is moved over the work. Tools that have been demagnetized will stay sharp longer, will cut faster, and are more accurate than magnetized units.

INDUCTION HARDENING

Saves Much-Needed Copper for Defense Use

Before induction hardening was adopted by a large automobile plant, it was necessary to use copper bushings in the rocker arms to prevent them from wearing out the shaft. Increasing the shaft hardness from 20 to 50 Rockwell C by high-frequency heating and quenching has resulted in a hardness sufficient to prevent shaft wear when the rocker arm is used without the copper bushing. Nearly five million shafts have been processed during the past two years without a single reject that could be traced to improper heating. Since about 14,000,000 bushings weighing four-fifths of an ounce each were needed annually, a savings of 35 tons of copper resulted.

In the manufacture of rocker arm shafts, the steel is cut in 12½-inch lengths out of ¾-inch bar stock, and ground. Shafts are then bored, counterbored, and faced for length simultaneously in one machine at the rate of 185 per hour, using 26 machines to maintain the present schedule of 12,000 units daily. The shafts are then hardened inductively by a "two shot" process, necessary because localized hardening at six different points around each oil hole in the shaft is desired. Units are dropped into holes where they are held in position by a cam supporting the end. High-frequency current from a Westinghouse 240-kva, 3000-cycle generator is applied at three sections which are heated to about 1500 degrees, Fahrenheit, and quenched. The cam then releases the shaft causing it to drop two inches, and the process is repeated. Hardening of the entire shaft is not desirable as it would become brittle and susceptible to breakage.

Shafts are hardened six at a time in an upright hardening furnace in which the heating and quenching cycle is 4½ seconds. No oxidation of the surface results, and there is no grain growth of the unhardened metal sections. Although there is some distortion of the hardened shaft, further machining except for finish grinding and lapping is unnecessary.

STRAIN GAGE

Prevents Breakdown of Industrial Machinery

In some types of machines, such as punch presses, shears, and press brakes, the strain during a cycle of operation occurs for a very short period of time —rising abruptly to the maximum and then falling sharply to zero. It is this kind of machine for which a new electro-magnetic gage has been developed.

It is now more serious to have a machine out of commission than ever before. The loss in production is doubly great because a longer-than-normal idle period is probable. Men, materials, and

machines that are sorely needed in building new machines must be diverted from their production roles to replace a broken part.

The gage need not be applied directly to the vital part of the machine under strain but it can be applied to any part of the machine whose stress represents the equivalent stress on the vital part. The gage, comprising a rod, lever arm, and head, looks like a side view of an automobile jack. The handle is the gage rod, the jack is the lever arm, and the base is the gage head.

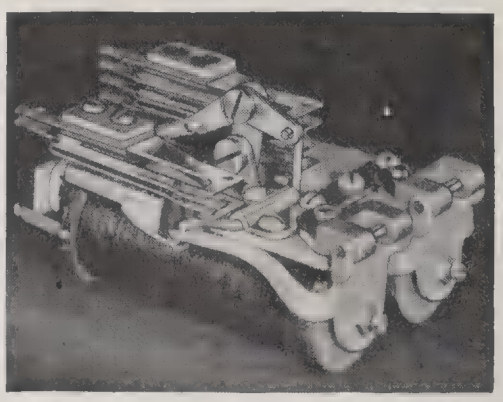
The rod is fastened at either end to the machine in the direction of the strain. The lever arm, attached at its outer end to the machine, is at right angles to the rod. The gage head is mounted on a plate that also is attached to the machine at a point on a line with the lever arm. The gage head consists of an armature operating within two coils.

Before the job is started, the position of the armature within the coils is adjusted so that a zero reading is registered on a connected instrument. When the machine is put into operation and strain exerted, the rod pulls down on the lever arm. The arm in turn pulls down on a pin in the armature and moves the armature to a new position within the coils. This affects the electromagnetic relationship between the armature and coils in accordance with the amount of strain exerted. The instrument, previously calibrated against known strain loads, then indicates to the machine operator the extent of the unknown strain.

RELAY

Uses Current Only When Operating

Positive operation and low current consumption are features of a new start-stop relay which has been recently designed for remote-control starting and stopping of radio transmitters, drainage pumps, and other appliances. This new relay, announced by Automatic Electric Company, operates and releases over two wires, with a common return. A typical method of operation is by the use of a two-way key, which is thrown into one position to close the relay and into the other position to release the contacts. The operating circuit of the relay opens immediately after the contacts open or close; thus operating current is consumed for only about 1/10th of a second.



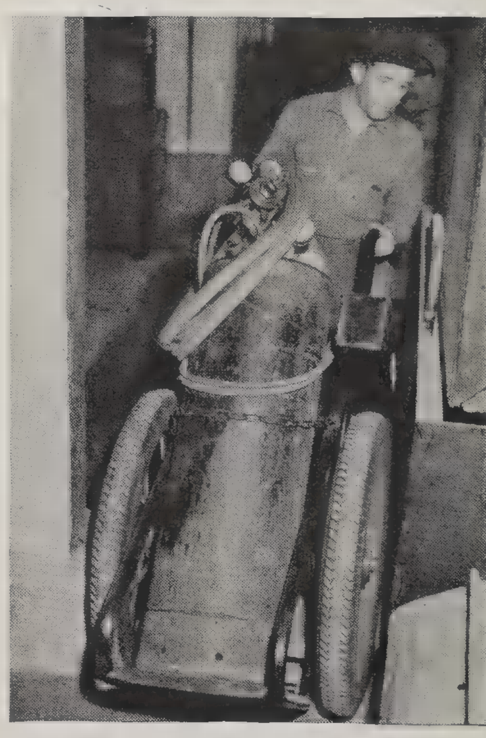
Economical of operating current

This new relay, available with any number of contacts up to 18, has been tested under operating conditions over a temperature range of from —22 to +131 degrees, Fahrenheit.

CART

For Easy Transportation Of Welding Tanks

Handling of welding tanks is facilitated by the use of a new narrow-width cart recently designed by Garlinghouse Brothers. This cart, shown in one of our illustrations, has a total width of only 24 inches yet carries the two tanks required for oxy-acetylene welding. These tanks, instead of being placed side by side, are set one behind the other, making possible the narrow width which is so desirable for use in crowded shops or narrow aisles.



Through a narrow door

Either tank may be moved independently of the other, as the acetylene cylinder is inserted at the front while the oxygen tank rests on its own platform in the rear of the cart. A tool box and two rod holders, for long and short rods, are attached to each cart in convenient positions.

The chassis is mounted on large pneumatic tired wheels so that the cart may be wheeled over rough, uneven ground or littered floors.

The Thunderbolt

Although Complete Specifications for New Interceptor Cannot be Told, It Promises to be Most Effective

ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

Congressional reports would have it that our pursuits are not equal to the pursuits of other nations and that our P-40 is well behind the times and only suitable for advanced training. The Congressmen who voiced this opinion did not know that the P-40 was followed by the P-40 A, B, C, and so on, which may be reckoned among the world's fastest and most effective fighters. Perhaps, also, the Congressmen in question had never heard of Republic Aviation's Thunderbolt, known technically as Republic XP-47B. This remarkable interceptor plane is perhaps the very first single seater to be powered with a 2000 horsepower engine. While specifications remain secret, there is reason to believe that the Thunderbolt is the most effective interceptor produced anywhere in the world. Tests of the ship, which is shown in our photograph, were remarkably successful. The Thunderbolt is an interceptor which has the strong fire power needed to attack enemy bombers and fighters. Readers will note that to absorb the enormous amount of power developed, a four-bladed airscrew of large diameter has to be employed. On the under side of the wing a hole is shown, uncovered. Into this the landing gear retracts, with the surface automatically smooth after retraction. The picture shows a very wide tread of the landing gear in relation to the span of the wing. Any pilot who has to come down at the speed of a heavily loaded airplane of this type will understand fully why.

It is an open secret that the Thunderbolt will be built in large numbers and it is certain to give a good account of itself. Another remarkable thing about this new ship is that it was in the air exactly eight months after the order to begin work had been received from the Army Air Corps, an indication of sound knowledge on the part of the engineers.

PLYWOOD

Utilized as Float, Conserves Aluminum

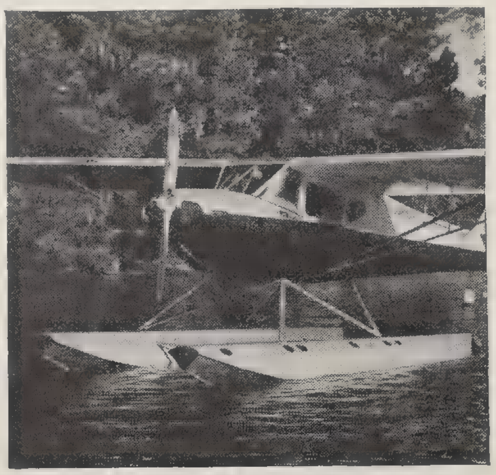
In these days, when every pound of aluminum is precious, it is only logical that resort should be had to plywood, particularly in the aircraft industry for civil use. It is not surprising, therefore, that the Heath Company has produced a laminated plywood float with plastic bonding or glueing. In earlier days, when glue was of animal or vegetable origin, it was never quite bacteria-proof and never quite waterproof. Floats built then had the unfortunate habit of peeling off.

In the floats shown in our photograph, Honduras mahogany veneer is used for the skin, fastened together with perfectly waterproof and resistant cold resin glue. Another advantage of

When 2000-horsepowered Thunderbolts are hurled at the enemy . . .

the use of plywood in floats is that the top skin of the float is one piece of plywood 15 feet long, bonded to the float structure in a large hydraulic jig that applies pressure evenly to the whole surface. The float is left in this jig for four hours. No nails are used so that the outside surface is perfectly smooth.

Another innovation lies in the transparent inspection covers which enable the operator to check with a flashlight



For inexpensive conversion

for water in the floats. Water rudders are placed at the end of the floats and actuated in conjunction with the ordinary rudder located at the tail end of the fuselage.

These floats, which weigh only 69 pounds apiece, have been approved for seaplanes not exceeding 1,560 pounds in weight. It is an attractive idea to have a low-powered airplane which can be used either as a land plane or, with these cheap and efficient floats, as a seaplane. Perhaps the only criticism we might make is that the landing gear may have too many exposed resistance parts in struts and bracing wires.—*A. K.*

CIVIL AIR PATROL

Offers Possibilities of Varied Services

The Office of Civilian Defense has had the good fortune to secure as Aviation Aide to the Director, Major Reed G. Landis, famous American pilot of the first Great War.

The first and most important task of the aviation aide lies in the organization of the Civil Air Patrol which is prepared to enroll all persons qualified as flyers, owning their own planes and wishing to give service to the nation. It is easy to enroll. There is no specific examination and a man who is a pilot but has no airplane may act as co-pilot for a pilot-owner. Special training will be given to the enrollees in military and naval air tactics, navigation, air raid warning service, and similar tasks.

Perhaps the most important question to be asked by people wishing to enroll would be: "What are the services that the Civil Air Patrol could render in national defense?" These are enormous and important. To begin with, they might guard all airports, and the guarding of airports has been proved to be vitally important by the events in Hawaii and the Philippines; and there are two thousand airports to be guarded in the United States. Courier service may be of great importance to the Army. No matter how many military pilots and planes we may have, observation patrol of back country areas is likely to be desirable. C.A.P. pilots may be required to tow aerial gunnery targets, thereby releasing military equipment for more important duty. C.A.P. personnel, familiar with all types of aircraft, can assist the air raid watchers. Highway traffic control from the air may, at times, be of value. When a military aircraft is forced down, the new organization may help to find them.

Obviously, not all of the possibilities of C.A.P. are yet understood, but the Army is backing the new organization to the fullest extent.—*A. K.*

ICE

Combatting a Scourge of the Upper Air

Ice is prevented from forming on the windshields of airliners operated by United Air Lines by a system which has been 18 months under development and has proved completely satisfactory.

The windshield used in this system consists of a front pane of quarter-inch safety plate glass and a rear pane of eighth-inch transparent plastic, with a quarter-inch air space separating the two. Air, heated to 175 degrees, passes through a duct from the plane's cabin heating system, on through the air space of the windshield, and then through an exhaust duct to the outside of the plane. The air, controllable by the captain through the operation of a valve at his elbow, moves at the rate of 60 cubic feet per minute. In installing the double windshield, 10 by 35 inches, on the captain's side of the cockpit it has become possible to eliminate the small vertical post which has been standard between the large fixed panel and small sliding panel of the DC-3 windshield, thereby providing the Captain with unobstructed vision. It is noteworthy that J. A. Herlihy, Executive Vice-President of United, tried fluids, windshield wipers, and the application of heat to the inside of the windshield before deciding on the system now being installed.

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

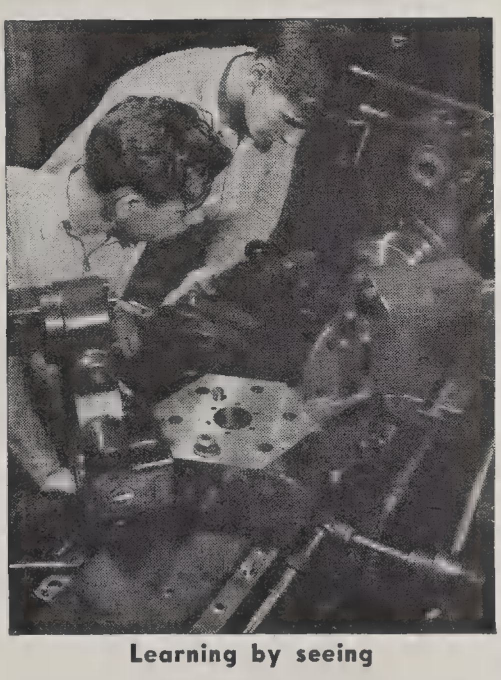
The Camera Enlists

FREQUENT requests have come to us recently asking how photography amateurs can do their bit in the defense effort. Individual instances will vary but, as we see it, the opportunities are twofold: educational and publicity. Defense workers in various branches of activity must be taught how to perform their duties most efficiently, and publicity concerning these activities must be spread, in order to inspire non-workers to enlist part of their leisure time in some phase of defense work.

Publicity pictures, therefore, should demonstrate the many ways in which lay persons may help in one or another of the many branches of defense work. Also, they have the equally important benefit of advising the general public as to how public and defense workers must co-operate when the time comes—air raids, fires, and so on.

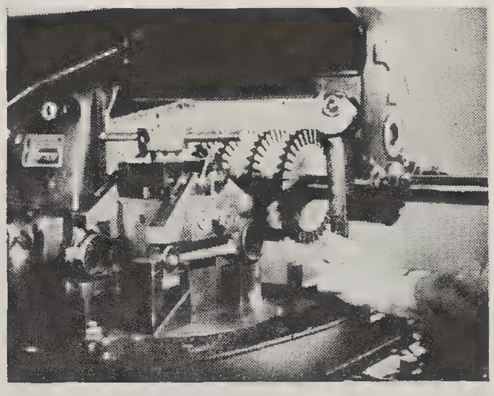
It is in the educational field, however, that the greatest opportunity lies. Volunteer services form the bulk of many defense activities. This means lack of experience or skill and, in frequent instances, even lack of knowledge. Volunteer teachers instruct the tyros, but this is slow work at best. A picture tells a thousand words, and even the best of teachers can do his or her job better if pictures or slides are used to supplement the lesson. In fact, a good set of pictures illustrating a task, step by step, in clear, sharp images placed where they receive good illumination, often can substitute for a teacher entirely, which means fewer teachers, more workers, and a wider dispersion of knowledge among many scattered groups. Paucity of teachers would have no meaning because you would not need them; all you would have to do is strike off duplicate sets of prints.

The power of the pictured lesson is well realized by the United States Office of Education, which is now in the process of directing the production of 50 reels of sound films covering various phases of machine-shop work. These are being reproduced in 16mm size and distributed, for the most part, to vocational schools and in industries where machine-shop training is being given.



Learning by seeing

By the nature of the assignment, educational pictures made with the still camera must show the details of the task as clearly as possible. This means close viewpoints, sharp focus, small diaphragm openings, and generous illumination with full exposure. From such negatives enlargements must be made that have good contrast throughout with adequate shadow detail. The size of the enlargements will vary in accordance with the requirements; for small groups perhaps 11 by 14 inches will do, for larger groups 16 by 20-inch prints may be needed. The slide would do the trick best of all, but the disadvantage here is that you must have a projector and a screen, whereas ordinary prints may be simply set on an easel and adequately lighted.



The movie camera teaches

The slide and the motion-picture film can tell a story more efficiently than the still picture, it is true, but there is this point also to consider: projection implies a darkened room which means that during the showing, the student can only watch and take mental notes. In the case of prints, however, a series of prints may be lined up on a wall to illustrate a practical sequence in some craft, and the student may actually build, or sew, or whatever, in accordance with the instructions indicated in the prints.

However, various crafts call for different approaches, and whereas in one case the print sequence would do the trick; in another, more complicated instance—as in the case of a machine-shop operation—the movie would be the more practical method of teaching.

When Condensers Are Scratched

THE plano side of a double condenser system is always subject to abrasions, particularly if it is of the type too large to be fixed in place. In one instance, such a condenser was injured

when it was being replaced with a smaller condenser unit for small negative work. This scratch showed up beautifully on every print projected with that particular condenser unit in place. This was obviously to be expected since the scratch was on the plano side of the condenser lens closest to the enlarger lens, therefore projecting on the easel almost as sharply as the negative itself. The remedy was to reverse the two condenser lenses in the condenser case, placing the good one on the bottom and the scratched one on top. The scratch was so diffused that it made no impression on the print.

Candid's Still With Us

"You can't take a picture in this light", said our table companion, to which we replied: "That's what you think," and went ahead and did it. The result is reproduced, an honest-to-goodness candid shot of a lad in a listening mood.

"The Problem"

The illumination was from a 100-watt bulb in the ceiling, reflection from the white tablecloth helping to fill in the shadow areas. Made with an Automatic Rolleiflex on Plus X film, the exposure was *f*/3.5 at 1/10 of a second.

Retouching Easel

A 14 by 17-inch unfinished wood picture frame found in an art store gave Mrs. Flora K. Howes, of New York City, an idea for a retouching stand. She bought the frame and had the frame maker build her another frame 14 inches square. The two were then hinged together, the square frame, serving as the bed of the easel, having a white card set in it for reflecting the light to the glass in the easel. A strut attached to each side of the bed held the easel upright at the desired angle. The easel was fitted with a 14 by 17 sheet of ground glass. When not in use the device easily folds up and occupies little storage space.

Easy Road to Composition

Composition is the bugaboo of most photography amateurs, although its basic principles are simple enough. In a recent one-man show in New York City, W. M. Westervelt, a teacher of photographic design and a member of the art staff of an advertising agency, demonstrated by a group of abstract studies that composition is simply a matter of working within a definite area to achieve "a comfortable picture."

"When I want to figure out how to get an interesting shot of some small object," he explained, "I set it down on a table, put one spotlight on it, and then I walk all around it, looking at it through a rectangle 2½ by 3½ inches in an 8 by 10-inch piece of cardboard. I never look at my subject matter except through this cardboard viewer. You can't compose just in general; you have to compose within a definite area."

Print Reducer

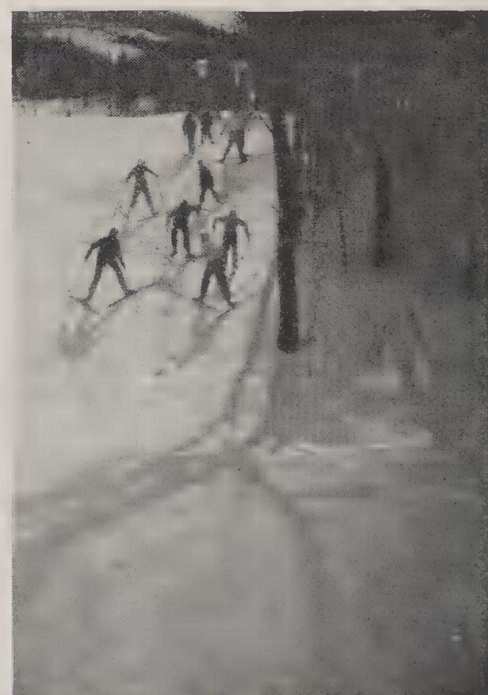
For toning down local areas in prints with distracting highlights and other spotty areas, the following formula has been successfully employed:

Solution A:	
Sublimated iodine	20 ozs.
Alcohol	10 ozs.
Solution B:	
Thiocarbamide	1 oz.
Water	10 ozs.

For rapid action use five drops each of Solutions A and B. Slower action is recommended, however. This calls for the use of five drops of A to 10 drops of B. The solution is applied with a bit of cotton on the end of a toothpick. As soon as applied to a particular spot, the area is immediately swabbed with a wad of cotton dipped in alcohol. The routine is repeated as often as necessary to achieve the desired tone.

Helps to Perspective

A picture in the distance, but only space in the foreground: How to shoot that distant picture without being handicapped by empty foreground? That was the problem facing LeRoy Roselieve, New York ski enthusiast, who invariably totes an Ektra with him wherever he goes, shooting Plus X. The long shadows



"Up Again"

in "Up Again" saved the day by darkening the foreground mass, which served also the auxiliary purpose of continuing the "frame" provided by the trees. The result gives an excellent idea of distance, which would have been killed by a white foreground.

In "Haven," meaning is lent the ski paraphernalia leaning against the wall by the distant figures and ski slopes. Here

"Haven"

the interest lies chiefly in the foreground, but without the distant scene the subject-matter would lack completion. Situations like these provide opportunities for introducing some of the tricks and methods by which photographers attempt to give their pictures the three-dimensional values they always strive for.

New Infra-red Material

An accidental observation by Dan Grossi, of the Wabash Photolamp Corporation, resulted in making available an infra-red emulsion which, when used with blackout flash illumination, is said to have a speed much greater than that of regular infra-red film. The film (made by Eastman) had previously been used exclusively for aerial infra-red photography. A piece of the film was cut up into 4 by 5 sheets for use experimentally. The results were so phenomenal that efforts were made to have Eastman furnish a regular supply. So now we have Infra Red Safety Film, Aero Type II, at present in size 4 by 5 inches only. At this writing, the emulsion is coated on thin Aero base, but Eastman plans shortly to use a heavier base similar to that used for other cut film.

Estimates of the speed range from three to 10 times the regular infra-red speed. We have not attempted to test the speed as yet, but results we have seen indicate that a negative of good density can be made outdoors at night with stop $f/8$ at a distance of 15 feet, shutter at 1/25 of a second.

Because the film is rather perishable, said to be good for only 60 days, the manufacturers recommend it be kept in the icebox when not being used. Due to this factor, also, film is ordered by the dealer for each customer. The film is sent by Eastman directly to this customer; the dealer bills the customer. This assures that the user will get the film without any delay.

Readers who desire further information on the subject of blackout flash work in general are referred to this department in the October, November, and December issues. Here they will find details on bulbs, exposure time, and so on.

• • •

What's New

In Photographic Equipment

Albert President Tripod ($25): Built-in swing camera platform permits vertical angle or horizontal shots with turn of knob. Adjustable camera screw fits all cameras. Leg tips reversible from points to rubber. Made of three-section tubular steel. Complete with tilt-head, weighs five pounds. Leg-lock adjustable from 28 to 62 inches.

"Flicker Frolics": New series of home movies produced by Official Films. First subject "The Race for Life," described as an old-time slapstick melodrama, with Mabel Normand, Mack Sennett, Ford Sterling, the Keystone Cops, and Barney Oldfield.

Da-Scope Kodachrome Viewer ($1.95): Folding slide viewer with translucent white plastic top, on which slide is mounted when viewer is open, permitting diffused illumination. Viewing lens magnifies image. Device measures $2\frac{3}{8}$ by $2\frac{3}{4}$ by $\frac{5}{8}$ inches.

"Britain's Commandos in Action!": Castle film record of raids by Britain's suicide squads on two Nazi-held Norwegian islands, available for users of 8mm and 16mm projectors in five sizes and lengths.

Agfa Finex Fine Grain Developer (now available in quart size at $1.75): Through recommended laboratory replenishing system, quart permits total of 60 rolls of 36-exposure miniature (35mm) film or 60 rolls B2 or 120 rolls, or equivalent, to be developed. Finex Replenisher sold separately at 75 cents an 8-ounce bottle.

Hollywood Titler ($9.75): Title cards may be photographed at 4, 6, 8 and 12 inch distance. For 8mm and 16mm camera users. Permits making zoom and superimposed titles; accurate alignment with custom-made camera base for your particular camera. All parts adjustable on base, permitting use for table top, copy work and extreme close-ups. Complete with two auxiliary lenses, celluloid target, instructions and titling data. Professional attachment ($5.50) makes possible turnover, turnabout, turnaround, flop up and down, revolving, and other titling tricks.

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AERIAL BOMBARDMENT PROTECTION

By Harold E. Wessman and William A. Rose

Detailed technical, rather than popular, discussion of making building construction resistant to effects of bombing, including characteristics of bombs, design procedures, present construction practice and proposed modifications, evaluation of shelter zones in existing buildings, air raid shelters, camouflage. Data were obtained from British experience, supplemented by extensive studies and governmental experiments applicable to American structural and architectual practice. Authoritative. Valuable to engineers, architects, technical advisers, construction material manufacturers. (372 pages, 5¾ by 9 inches, profusely illustrated.)—$4.10 postpaid.—*A. D. R.*

BETWEEN THE PLANETS

By Fletcher G. Watson

One of the new Harvard books on astronomy. It deals with comets and meteors, asteroids and meteorites. Written by a professional astronomer (at the Harvard College Observatory) for the advanced amateur astronomer—which is to say, for the rather serious home reader rather than for the reader who wants a book for the entirely uninitiate. It gives a thorough coverage of its subject, including the most recent findings. (222 pages, 5¾ by 8⅜ inches, 106 illustrations.)—$2.60 postpaid.—*A. G. I.*

DEFENDING AMERICA

By Creighton Peet

Just the right book to present to that 10 to 14 year-old lad who keeps asking you questions about the Army, the Navy, the Air Corps, and so on. It gives a clear picture for juveniles. (160 pages, 6¾ by 9¼ inches, well illustrated.)—$1.60 postpaid.—*A. G. I.*

TECHNICAL DRAWING

By Giescke, Mitchell, and Spencer

Second edition of the probably best book on its subject—most thorough, complete, and detailed. It is essentially a general introduction to drafting, suitable for college and high-school graduates. Chapters on: instruments and materials, instrumental drawing, geometry of technical drawing, lettering, projections, auxiliary views, revolutions, sectional views, axonometric projection, oblique projection, perspective, intersections and developments, dimensioning, shop processes, working drawings, gearing and cams, pipes, fittings and valves, welding representation, technical sketching, shading, patent office drawing, graphs, architectural drawing, structural drawing, topographic drawing, reproduction of drawings. Excellent sourcebook for men now polishing up to undertake defense drafting jobs but who feel a bit shaky. It gets down to brass tacks (thumbtacks). (687 pages, 6 by 9 inches, 1001 illustrations.)—$4.10 postpaid.—*A. G. I.*

THE RADIO AMATEUR'S HANDBOOK

"The most widely read technical volume on radio" is the way the publishers characterize this volume which is published yearly. The text is literally the Bible for thousands of radio "hams" throughout the world, but it now assumes increased importance due to the fact that thousands of copies of the new edition will be used in defense classes throughout the country. The subjects covered range throughout the entire field of radio, from fundamental principles to the design and construction of transmitters and receivers, all concerned with short-wave activity. (Completely illustrated with photographs and drawings.) —$1.10 postpaid.—*A. P. P.*

INTELLIGENCE, POWER AND PERSONALITY

By George Crile

Studies of the force that energizes man and animals, and accounts for their intelligence, power, and personality, by the noted Cleveland surgeon-scientist. Based mainly on thyroid and adrenals, heart and brain. Mainly of zoological interest. (347 pages, 6 by 9 inches, 41 illustrations.)—$3.10 postpaid.—*A. G. I.*

PLASTICS CATALOG 1942

What—a catalog reviewed in the book column? Yes indeed, because here is one catalog that is so much more than a mere listing of products that it has made for itself a definite place in the literature of the plastics industry. Bound in simulated leather, this volume has become an indispensable source of information and reference for anyone connected with or interested in plastics in general. The text

is divided into nine main sections, the titles being: Plastics in Defense; Materials; Plastics Engineering; Production Operations; Machinery and Equipment; Laminates, Vulc, Fibre; Plastic Coatings; Syn. Fibers and Rubbers; Index and Directory. The article material has been compiled by the foremost authorities and experts in the field. (More than 600 pages, $9\frac{1}{2}$ by 12 inches, completely and thoroughly illustrated.)—$5.00 postpaid. —*A. P. P.*

MISSION TO MOSCOW

By Joseph Edward Davies

COMPOSED of extracts from the diary, journal, personal and official correspondence, and the "Secret and Confidential" documents of the former United States Ambassador to Russia, this book is a report to the American people, with the sanction of the Department of State. A moving, fascinating delineation of facts and personalities in Russia from 1936, as observed and studied by an official representative of this country, of whom President Roosevelt said: "You exercised a happy faculty in evaluating events at hand and determining with singular accuracy their probable effect on future developments. Your judgments of men and measures were sound and dependable." (663 pages, 6 by $8\frac{1}{2}$ inches, indexed, illustrated.)—$3.10 postpaid.—*A. D. R., IV.*

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HANDBOOK OF CHEMISTRY AND PHYSICS

ANNUALLY this classic reference book is revised to keep pace with research work, the revision process necessitating extensive changes during recent years. To attempt to give a comprehensive idea of the contents of the book would take far more space than is available. About all that can be said here is that an attempt has been made to include material on all branches of chem-

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By Alfred A. Ghirardi

WHILE essentially a book for the radio service man, keeping him up to date with current equipment and servicing practices, this book will also find ready acceptance by engineers, experimenters, amateurs, and others concerned in any way with the technical aspects of radio. (710 pages, 9 by 11 inches, numerous diagrams, charts, and tables.)—$3.60 postpaid.—*A. P. P.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

AIR RAID SHELTERS is an eight-page circular which illustrates and describes a corrugated shelter made to accommodate up to 50 persons. The shelter has gas-tight end walls and a gas lock or chamber can be included in the set up. An "economy" type of shelter for individual families is also described. *Armco Drainage Products Association, Middletown, Ohio.—Gratis.*

CURRENT CONTRIBUTIONS ON INSECT CONTROL is a brief report on recent findings with respect to the control of insect pests of fruits, vegetables, and ornamental plants. *New York State Agricultural Experiment Station, Geneva, New York.—Gratis.*

PLEXIGLAS FABRICATING MANUAL is a 48-page booklet prepared specifically for organizations fabricating Plexiglas for defense purposes. It is of immediate interest, however, to other users of thermoplastics. The text of the booklet covers such phases of the work as machining, forming, cementing, finishing, and repairing. A large number of illustrations supplement the text. *Rohm & Haas Company, Washington Square, Philadelphia, Pennsylvania.—Gratis.*

PHOSPHATES ON THE FARM, by Chester F. Hockley, is an eight-page pamphlet which deals with the whole problem of phosphatic fertilizers as used in modern agriculture. Emphasis is placed not only on the phase of plant nutrition but also on that of farm animals which are fed products of the soil. *The Davison Chemical Corporation, Baltimore, Maryland.—Gratis.*

HAND PUMPS is a 4-page illustrated bulletin describing high-pressure pumps for testing purposes and for operating jacks and small hydraulic tools. Pressure capacities of the pumps range from 1,500 to 30,000 pounds per square inch. Ten different types are illustrated and mechanical characteristics are tabulated. *The Watson-Stillman Company, Roselle, New Jersey.—Gratis.*

ON THE PIPELINE FRONT is a 12-page booklet devoted to a description of the pipeline industry. The text tells the dramatic story of the men and machines composing this industry which is contributing greatly to the progress of commercial and domestic life all over the world. *Form 7218. Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

ELECTRON MICROSCOPES AND THEIR USES, by Joseph A. Becker and Arthur J. Ahearn, is a 16-page illustrated booklet which gives a bit of the history of microscopes in general and describes the design and construction of the modern electron microscope. Included are a number of reproductions of photographs made with this instrument, showing details never seen by men until the development of the electron microscope. *Bell Telephone Laboratories, Inc., 463 West Street, New York, N. Y.—Limited Free Distribution.*

MEN YOU LIKE TO MEET is a 24-page collection of short "human interest" stories about highway heroes—truck drivers whose everyday work is often correlated with an aura of glamor and romance. *American Trucking Association, Washington, D. C.—Gratis.*

BAND AND BLOCK RUBBER TRACKS is an eight-page bulletin which discusses the principles of these two types of tracks for vehicles, illustrates their differences, and tells of their advantages over the steel crawler type of vehicle. Data tables are presented for some of the factors involved. *The B. F. Goodrich Company, Akron, Ohio.—Gratis.*

CHEMICALS BY GLYCO is a 112-page book giving detailed information on a wide range of commercial chemicals, including suggested formulas for the manufacture of numerous finished products. Flameproofing and waterproofing agents, synthetic resins, and waxes, emulsifying agents, and so on, are dealt with in detail.—*Glyco Products Company, Inc., 230 King St., Brooklyn, New York.—Gratis.*

ENGINEERING TABLES is a 12-page manual designed for hydraulic engineers and others in allied lines. Among the table headings are: capacities of hydraulic rams, discharge of water for circular straight edge orifices, strengths of materials, and useful hydraulic formulas. *Bulletin No. 120-A. The Watson-Stillman Company, Roselle, New Jersey.—Gratis.*

SHIPBUILDING TERMS is a 64-page wire-bound book which presents the text of a course developed for defense training classes in the ship-building occupations. The purpose of the text is to acquaint the reader with the meaning of ship terms, ship locations, and abbreviations of ship terms. *American Technical Society, Drexel Avenue at 58th Street, Chicago, Illinois.—50 cents.*

RADIOTRON DESIGNER'S HANDBOOK is a 365-page bound volume designed for radio engineers, amateurs, experimenters, service men, and others interested in the principles of practical circuit design. The text is divided into eight chapters covering the fundamentals of the subject. There are a number of illustrations and numerous reference charts and tables. *Commercial Engineering Section, RCA Manufacturing Company, Inc., Harrison, New Jersey.—$1.00.*

ELECTRONIC CONTROL is a technical reference bulletin covering resistance welder heat-controls, synchronizers, synchronous timers, and power and control units for welding equipment and automatic machinery of various types and capacities. *Weltronic Corporation, Detroit, Michigan.—Gratis.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

DR. PLASKETT'S detailed account of the acceptance tests for the great 82″ mirror for the McDonald observatory, reprinted from *Contributions from the McDonald Observatory, University of Texas*, begun here last month, is concluded as follows:

The focal length of the completed mirror was carefully measured before the reductions of the final measures, as 319.656″, or 811.928 cm; and with this focal length the intersections of the 12 zones used in the visual tests and the 15 in the Hartmann test were computed anew, and are given in Table I. On the left-hand side the units are inches and on the right centimeters, as the separation of the zones, which are those of the diaphragm used in the Hartmann test and the pitch of the screw used in measuring the photographs, are given in these units. The recomputation was necessary, as the difference between these positions and those for the focal length of 320″ amounts to 0.005″, or 0.12 mm, which is quite significant with so good a mirror as the 82″.

The visual measures of the intersections of the pencils from the various zones were made on October 12 and October 14, immediately after the parabolizing was completed, and again on October 25 and November 1, after the mirror was aluminized. There were four independent sets of measures on October 12 and six each on the other three dates, equally divided between, and alternated by, Mr. Lundin and myself. The separation of the scratches was measured by dividers on a steel rule divided into fiftieths and hundredths of an inch. These measures, or rather the differences between the observed and the computed position ΔR, are given in thousandths of an inch; for, although in a single setting three places are not significant, they more nearly approach it in the mean of four, and still more of six settings. The probable errors of the mean of six settings is 0.0022″ for the outer four zones, 0.0033″ for the intermediate, and 0.0043″ for the inner four zones.

The results of these four measures are given in Table 2, where the first column contains the zone number, the second and third and the succeeding three pairs of columns give the ΔR's, the difference between the observed and computed positions of the zonal intersections, and their transformations into the curve of shape for the four dates. It will be noted that the values of ΔR which, it must be remembered, are expressed in thousandths of an inch and are four times the longitudinal aberrations at the principal focus, vary somewhat on the different dates, being lower on October 12 and 25 than on October 14 and November 1. While the accidental errors of the means of the sets, varying from $\pm 0.002''$ to $\pm 0.004''$, and increasing from edge to center of the mirror, may account for a considerable fraction of the variation, there may be something systematic about the differences, such as temperature variations on the different dates, or change of figure produced by irregularities in the thickness of the aluminum coating.

So far as the latter effect is concerned, it may be dismissed as negligible, as there is no appreciable systematic difference in the run of the ΔR's before the coating, on October 12 and 14, and after it, on October 25 and November 1. There may be, however, some evidence of a temperature effect on the figure of the 82″ mirror. On October 12 and 25, when the variations in the ΔR's were somewhat smaller than in the other two measures, the decrease in temperature, taken from a thermograph near the mirror, between midnight and the time of the tests, about 11:00 A.M., was 1°.2F, while on October 14 the change was 2°F. However, on November 1 the temperature was constant within 0°.3F, so that, on the whole, a variation of figure with small temperature changes is not demonstrated.

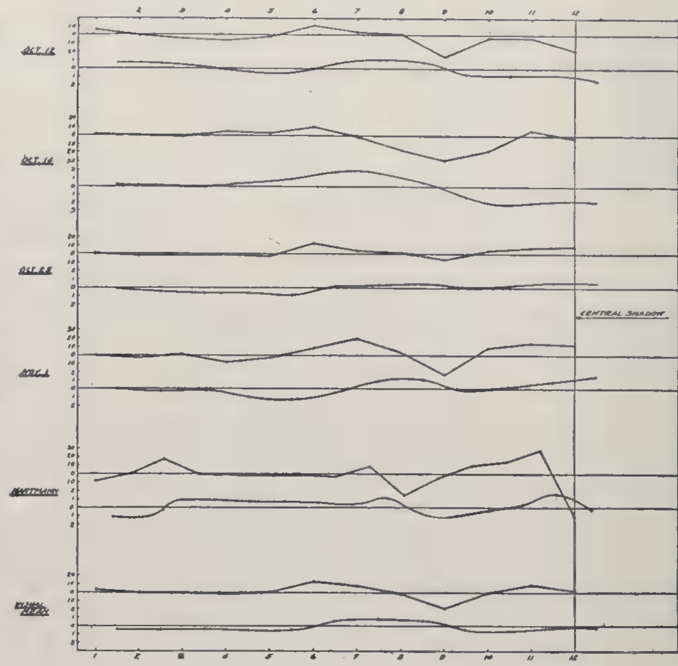


Figure 3: Final test. Upper curves of the ΔR's. Lower curves are the curves of shape

We may, hence, consider that the variation in ΔR's are mainly accidental and use the mean values of the 22 different settings as best representing the figure of the mirror, and these means are given in the last three columns of Table 2. The mean ΔR's are all remarkably small, less than 0.004″, or 0.001″ at the principal focus, except for zones 6, 9, and, to a smaller extent, 11. These indicate only a very small deviation from a perfect figure, the maximum longitudinal aberration at the principal focus in the last column being 0.005″, or 0.12 mm, as compared with the 0.4 mm allowed by the specifications. The total area of the three divergent zones is only 15 percent of the area of the surface, so the effect on the resultant image will be small. The maximum diameter of the circle of confusion, computed geometrically from the largest longitudinal aberrations, is 0.014 mm, as compared with the 0.05 mm of the specifications. Furthermore, 85 percent of the light is concentrated in a diffusion disk of an average diameter less than one-third the foregoing.

The ΔR's from Table 2 are represented graphically in Figure 3, the scale divisions being in hundredths of an inch, although numbered in thousandths (these being used rather than millimeters since all the measures were more conveniently

Zone	Radius of Zone (In.)	Diff. Radius (In.)	Zone	Radius of Zone (Cm)	Diff. Radius (Cm)	Hartmann Meas. ΔR	Hartmann Meas. ΔF	Mean Astigmatism (Mm)
1......	40.250	2.539	1....	101.5	6.365	−0.32	−0.08	+0.11
2......	37.711	2.229	2....	97.	5.808	−0.11	− .03	+ .06
3......	35.211	1.942	3....	92.	5.224	+0.36	+ .09	− .03
4......	32.721	1.677	4....	87.	4.653	−0.11	− .03	+ .04
5......	30.227	1.431	5....	82.	4.149	−0.15	− .04	− .01
6......	27.736	1.204	6....	77.	3.658	−0.16	− .04	− .02
7......	25.231	0.996	7....	72.	3.206	−0.12	− .03	+ .07
8......	22.727	0.809	8....	67.	2.776	−0.17	− .04	+ .08
9......	20.231	0.641	9....	62.	2.374	+0.13	+ .03	+ .01
10......	17.738	0.492	10....	57.	2.007	−0.72	− .18	+ .01
11......	15.217	0.362	11....	52.	1.671	−0 22	− .06	+ .01
12......	12.744	0.254	12....	47.	1.363	+0.15	+ .04	− .02
13......	10.277	0.165	13....	42.	1.090	+0.24	+ .06	+ .08
14......	7.729	0.093	14....	37.	0.846	+0.62	+ .15	− .10
Center..	0	0	15....	32.	0.632	−1.34	−0.33	−0.06

Table 1: Positions of intersections (max. diam., 0.025 mm)

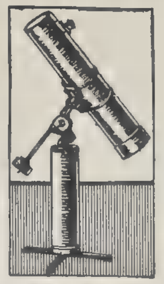
made in those units). The curves of shape computed from these ΔR's are given immediately below each curve of ΔR, the units here being millionths of inches. The maximum departure from the mean paraboloid in the lowest curve is 0.0000007″, considerably less than a twentieth of a wave.

The Hartmann Test: There remains one further test of the surface, the well-known Hartmann test, which was requested by the purchasers early in the negotiations, the diaphragm being made according to their specifications. The latter contains 60 holes, each about 38 mm in diameter, spaced along twelve radii 30° apart. The holes cover 15 zones of the surface twice, the two sets being 90° apart to determine the astigmatism. The radii of the zones are given in Table I in centimeters, successive zones being 5 cm apart except that the distance between No. 1 and No. 2 is 4.5 cm. This diaphragm was placed directly over the aluminized mirror, which rested on the table of the polishing machine and was turned into a vertical position for both visual and photographic tests.

Several precautions were taken to insure reliable results on these tests. The principal difficulty encountered in my earlier tests of the 72″ Victoria and the 69″ Delaware mirrors had been temperature stratification in the Brashear testing chamber. This difficulty was much less troublesome at Cleveland, owing to the better temperature correction and to the tests being made in an open room instead of the closed 6′ square tube at Allegheny. Nevertheless, it was still present, as the images of the zonal apertures on the plates were all elongated in the vertical direction. To overcome as much as possible such temperature difficulties, the mirror was always kept horizontal, except for the few minutes the photograph was being made, so that it must have been at practically constant temperature throughout. Four exposures were made in each set, the mirror being rotated 90° each time, so that the longitudinal aberrations and the astigmatism could be tested not only from the two sets of apertures on each plate but also from the horizontal sets only, on successive plates, in the hope of overcoming stratification effects.

The four plates yielded four determinations of the ΔR's and four of the astigmatism. The average probable errors of the mean values, which, unlike the visual settings, did not increase in the inner zones, was ± 0.21 mm, which, compared with the visual average of ± 0.082, makes the photographic probable error over 2.5 times greater than the visual. The values of the photographic ΔR's and of the longitudinal aberrations at the focus are given in the seventh and eighth columns of Table 1. These, reduced to the same scale as those of the visual tests, are shown graphically in the fifth group of Figure 3. Although these show a trend similar to the visual graphs, they are naturally, owing to the higher probable errors, considerably more ragged and are entitled to considerably less weight.

The principal value of the photographic method is its definite test of the presence



Zone	Oct. 12		Oct. 14		Oct. 25		Nov. 1		Mean ΔR	Mean Curve	ΔF at Focus (Mm)
	ΔR	Curve	ΔR	Curve	ΔR	Curve	ΔR	Curve			
1....	+0.006	+0.7	−0.001	+0.1	+0.001	−0.1	0.000	0.0	+0.0035	−0.4	+0.02
2....	−.001	+0.6	.000	+0.1	−.002	−.4	−.003	−0.3	.0000	−.4	.00
3....	−.005	+0.2	−.001	0.0	−.001	−.6	+.001	−0.2	.0000	−.4	.00
4....	−.007	−0.4	+.005	+0.5	.000	−.6	−.008	−1.0	−.0022	−.5	−.02
5....	−.003	−0.5	+.003	+0.8	−.003	−.9	−.003	−1.3	.0000	−.5	.00
6....	+.011	+0.6	+.011	+1.7	+.013	+.2	+.009	−0.5	+.0125	+.6	+.08
7....	+.003	+1.0	−.001	+1.6	+.004	+.4	+.020	+1.0	+.0008	+.7	+.01
8....	+.001	+0.7	−.016	+0.5	+.002	+.5	+.004	+1.1	−.0015	+.6	−.01
9....	−.025	−0.7	−.023	−1.2	−.006	+.1	−.023	−0.3	−.0190	−.6	−.12
10....	−.004	−0.8	−.017	−2.1	+.004	+.3	+.009	+0.2	−.0005	−.6	.00
11....	−.004	−0.8	+.007	−1.8	+.008	+.6	+.014	+0.8	+.0078	−.2	+.05
12....	−0.019	−1.4	−0.003	−1.9	+0.010	+0.6	+0.012	+1.5	+0.0015	−0.2	+0.01

***Table 2:* Visual measurements of ΔR (max. diam., 0.014 mm)**

of astigmatism. The mean differences between the longitudinal aberrations at the principal focus in two azimuths on the mirror 90° apart are given in the last column of Table 1. If not wholly due to accidental errors, as seems likely from those determined above, there is certainly no systematic trend of the signs, the algebraic mean being only +0.02 mm, and it may be safely said that the surface is free from astigmatism.

The Hartmann criterion T, obtained from the formula

$$T = \frac{200{,}000}{F_0^2} \cdot \frac{\Sigma r^2 \Delta F}{\Sigma r}$$

where F_0 is the focal length, ΔF the longitudinal aberration at the principal focus, taken without regard to sign, and r the radius of any zone, simply gives the weighted mean value of the diameter of the geometrical confusion circle expressed in terms of $F_0/100{,}000$, while 2.0626T is its apparent diameter in seconds of arc. The values of T were computed for each of the four visual measures and for the single photographic test, and are given in Table 3. This was done for completeness only, as the value of T obtained from the mean of the 22 visual measures of ΔR at the center of curvature (given in the last line of Table 3) is obviously of much greater weight and is taken as more truly representing the optical qualities of the mirror. The maximum diameter of the diffusion disk was calculated above as 0.014 mm, less than one third the 0.05 mm permitted by the specifications, but is nevertheless nearly four times larger than the average diameter of 0.0039 mm in the last line of Table 3. There is, however, such a small proportion of the total light entering into this expanded disk that, in comparison to the central condensation, it will be quite inappreciable.

It will be of interest to compare the optical qualities of the 82″ mirror with those of other large reflecting surfaces which have been similarly tested. For this purpose the criterion T forms the best guide, as the errors or aberrations and the diameter of the geometrical diffusion disks are directly proportional to T. The following list comprises all those known to me, as the Mount Wilson 60″ and 100″ mirrors have had, to the best of my knowledge, no measures of their aberrations published.

72-inch Victoria mirror[1]...... T = 0.12
69-inch Delaware mirror[2]..... T = .14
74-inch Toronto mirror[3]...... T = .20
82-inch Texas mirror......... T = 0.050

Not only has the Texas mirror much smaller measured errors than any other, but such a relatively large proportion of the figuring was performed with large tools that the surface must be remarkably smooth and regular. This was, indeed, amply demonstrated by the Foucault and Ronchi tests, and it can be safely stated that the quality of the 82″ mirror of the McDonald Observatory is unequaled by any mirror previously made and tested.

[1] Computed from the aberrations published in *Pub. Dom. Ap. Obs.*, 1, 41, 1920.
[2] *J. Opt. Soc. Amer.*, 23, 293, 1933.
[3] *Pop Astr.*, 44, 349, 1936.

Kind of Measure	Date	Number of Measures	Hartmann T	Weighted Diameter of Geometrical Diffusion Disk	
				Millimeters	Seconds
Visual...........	Oct. 12	4	0.080	0.0064	0.17
Visual...........	Oct. 14	6	.070	.0052	.14
Visual...........	Oct. 25	6	.042	.0032	.09
Visual...........	Nov. 1	6	.085	.0068	.18
Photographic......	Oct. 26	4	0.100	0.0078	0.21
Mean of all visual measures.	....	22	0.050	0.0039	0.10

***Table 3:* Results of the tests**

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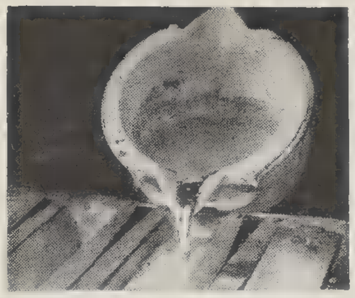

THE reason why aluminum has become such a choke-point in the present-day scheme of things is put forth in detail in the article starting on page 232. Our cover photograph shows molten aluminum being poured into molds from a ladle which has been filled from an electrolytic cell.

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SCIENTIFIC AMERICAN

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NINETY-EIGHTH YEAR **ORSON D. MUNN, Editor**

MAY • 1942

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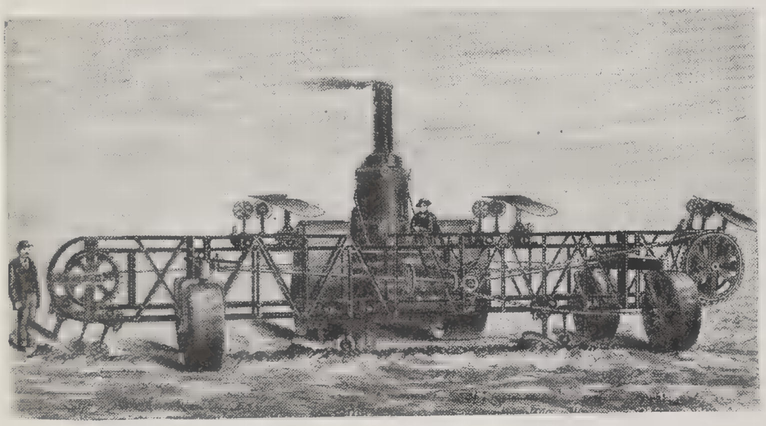
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of May, 1892)

RECLAMATION—"The business of securing waste rubber and recovering it obtained its impetus soon after the expiration of the Goodyear patents. Before that time the scrap, particularly that which was vulcanized, had been burned under the boilers or thrown away. . . . Briefly described, the process of reclaiming old rubber boots and shoes is as follows: The boots and shoes are roughly torn to pieces. These go to a grinding mill with a very decided friction motion which grinds the product to a fine powder. . . . The black powder is next put in iron pans, run into a vulcanizer and exposed to live steam for a number of hours at a temperature varying from 400° to 600° F. . . . Taken out of the vulcanizer, it may be put on a grinder, when it will readily form in sheets, and has very much the appearance of compounded stock that is unvulcanized. . . . There are few lines of goods in which recovered rubber cannot be used."

PLOW—"The accompanying cut, which is from a photograph taken while the machine was in operation, represents the rear view of a steam plow designed and manufactured by an engineer who has had some 18 years experience in steam cultivation and steam drainage in England, Germany, and Russia, and with every known



system. The apparatus is doing some excellent work, and is not only a working but a commercial success. As much as three acres per hour have been plowed in a most excellent manner, and the average of a day's work may be set down at 20 acres, which is being done at a cost of 45 cents per acre."

GUNS—"The largest of the modern high-powered guns, entirely of American manufacture, thus far completed, are the two 12-inch guns for the Monterey, the new monitor now nearly finished at San Francisco, and these pieces, as they were assembled at the Washington gun factory, were believed by our very competent ordnance officials to be equal, if not superior, to the best guns of the same caliber made anywhere else in the world."

PIGEONS—"Some important experiments have been recently made at Portsmouth relative to the use of carrier pigeons at sea. . . . On one occasion there was a thick fog on the other side of the channel; the pigeons set free circled for a few minutes around the boat, and then, getting their bearing, returned home."

COMET—"Prof. Lewis Swift, of Warner Observatory, reports a dispatch dated San Francisco, quoting Prof. Barnard as saying that his recent observations of the new comet reveal a remarkable state of affairs. Spreading out from the head is a complicated system of tails. At least a dozen distinct branches can be counted."

ELEPHANTS—"An elephant's digestive functions are very rapid, and the animal, therefore, requires daily a large amount of fodder —600 pounds at least. In its wild state the elephant feeds heartily, but wastefully. It is careful in selecting the few forest trees which it likes for their bark or foliage. But it will tear down branches and leave half of them untouched. It will strip off the bark from other trees and throw away a large portion."

MECHANICS—"A good mechanical eye is an almost essential requisite in a good mechanic. . . . No one can ever attain distinction as a mechanic unless he is able to detect ordinary imperfections at sight, so that he can see if things are out of plumb, out of level, out of square, and out of proper shape, and unless he can also detect disproportioned or ill-shaped patterns. . . . A little training and care is all that is necessary for success."

SAW—"Carnegie, Phipps & Co., who have the government contract for a portion of the armor plates of the new navy, are to add to the finishing plant of the armor department, a gigantic saw, weighing 110 tons, that will cut a nickel steel armor plate as an ordinary saw does a plank. . . . The saw has a blade 7½ feet in diameter, geared from above and revolving horizontally. With it an angular slab of cold nickel steel, weighing perhaps a dozen tons, is taken off like the slab of a pine log."

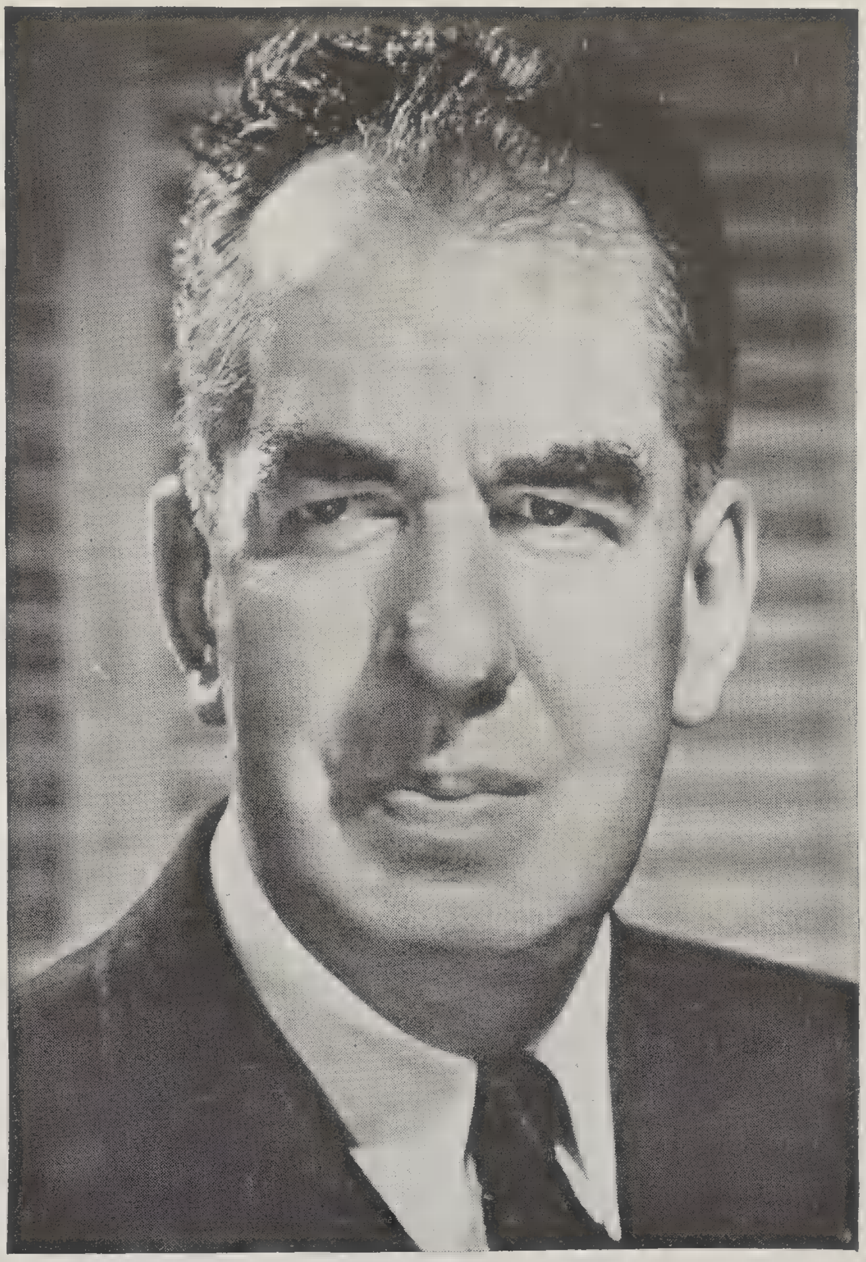
HIGH-SPEED PHOTOGRAPHY—"In a lecture on photographing bullets, delivered recently at the South Kensington Museum, Professor C. V. Boys explained his apparatus for the purpose. It consists of box lined with black cloth, in which the photographic plate is exposed, of a condenser, and of a system of wire circuits and knobs to give the spark which throws the shadow of the bullet on the plate, and thus takes the photograph. The bullet enters and leaves the box by two holes, covered with paper to exclude the light, and in passing the plate the bullet touches the terminals of two wires, composed of thin lead wire, thus partly completing the circuit, causing a flash to pass between the knobs of the plate condenser inside the box, and this flash, lasting less than one millionth of a second, takes the photograph of the bullet, no lens being employed."

LAND AND WATER—"It is estimated that the area of the dry land of the globe is 55,000,000 square miles and the area of the ocean 137,200,000 square miles. The volume of the dry land above the level of the sea is estimated at 23,450,000 cubic miles and the volume of the waters of the ocean at 323,800,000 cubic miles. The mean height of the land above the sea is 2,250 feet and the mean depth of the whole ocean is 12,480 feet. Of course these results are only approximate, but they help to render our ideas of these matters more definite."

FREIGHT FERRY—"The bold idea of ferrying loaded freight cars across Lake Michigan is soon to be put into practice. A large propeller is under construction at Toledo which will have a capacity of 21 cars, and it is expected to tow a barge carrying 15 cars, making 36 cars, or more than an average freight train."

MASONRY DAM—"The largest masonry dam in the world has lately been completed in India, in connection with the new water works for the city of Bombay. It is situated 65 miles north from Bombay, and stretches across the Tansa Valley. The dam is about two miles in length; 118 feet high; 100 feet thick at its greatest depth; 15½ feet at the top."

Personalities in Industry



A. W. HERRINGTON

RECENTLY elected president of the Society of Automotive Engineers, Mr. A. W. Herrington is the head of the Marmon-Herrington Company, manufacturers of specialized automotive equipment for civilian and military services, and chairman of the board of the Merz Engineering Company, a Marmon-Herrington subsidiary specializing in the manufacture of precision gages, instruments, and machines.

Mr. Herrington has an intimate acquaintance with military transport problems throughout the world, gained during World War I and since that time through frequent business trips to Europe, North Africa, and the Near and Far East. A forceful character, a dynamic speaker, and an accomplished organizer, it is his announced purpose, during the coming year, to use the influence of his position as head of the Society of Automotive Engineers to help synchronize the efforts of the entire industry into one great force for American defense and the successful prosecution of the battle against aggressor nations.

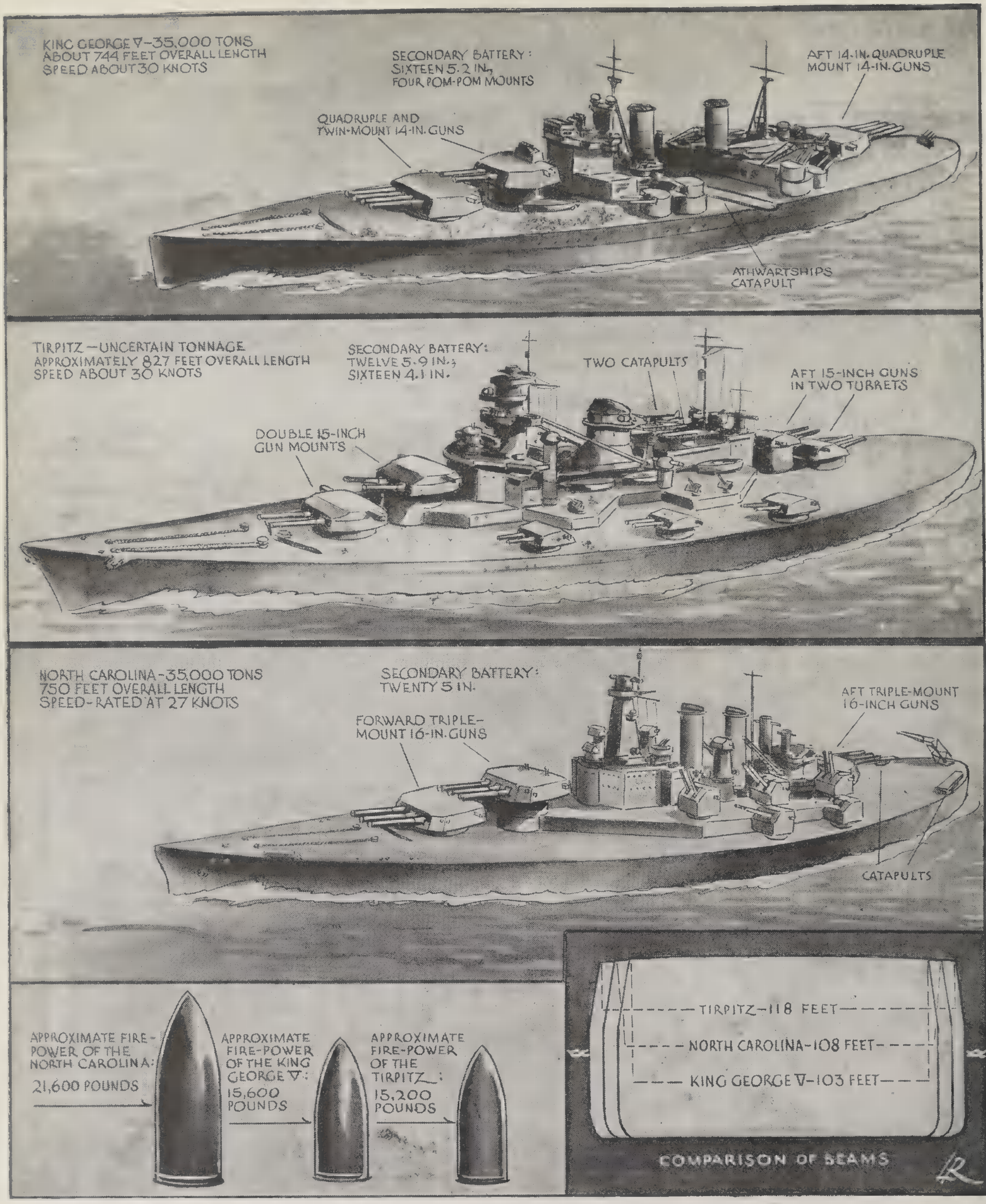
Born in Coddenham, England, Mr. Herrington came to America at the age of five with his parents, Arthur and Mary Matilda Herrington. He was married in Richmond, Virginia, in 1924, to Nell Ray Clarke, a newspaper woman of Washington, D. C. He has one son, Arthur Clarke Herrington, now 10. Mr. Herrington's primary schooling was received in Madison, New Jersey, and his technical education at Stevens Institute of Technology, Hoboken, New Jersey. His early automotive experience was gained with The Harley Davidson Motor Company, where he rose to the position of assistant chief engineer.

Mr. Herrington was in active service with the U. S. Army in the World War from October 1917 to September 1919. It was during this period that he became impressed with the futility of conventional drive automobile equipment for off-the-highway military service and determined to do something about it. Between 1921 and 1931, he was associated with several different motor car, truck and bus companies, and with the U. S. Army and Marine Corps as consulting engineer. He is the designer of various military vehicles and is also the originator of the idea of converting standard mass-production trucks to all-wheel-drive.

In March 1931 Mr. Herrington became associated with the late Walter Marmon, as vice-president and chief engineer of The Marmon-Herrington Company at Indianapolis, Indiana, in the design and manufacture of high-traction automotive vehicles of all types, for the most difficult civilian services, such as in the oil fields, logging camps, and so on, and for military usage. In August 1931 Mr. Herrington became president of the company, Mr. Marmon becoming chairman of the board.

As a result of his pre-war travels to far-away lands, Mr. Herrington's engineering ability is probably better known in such lands as Iran, Iraq, Australia, Africa, and China than here at home. His huge all-wheel-drive trucks are serving the oil industry in the jungles of South America, in the tractless desert wastes of Arabia, and in other remote regions.

Familiarly known to his friends and associates as "Colonel," Mr. Herrington is a member of The Indianapolis Service Club, an organization of World War Veterans, and never fails to attend the weekly luncheon meetings when he is in town. His interests, aside from business, are: squash, lacrosse, yachting, deep-sea fishing, hockey, and big-game hunting. He is a member of the Episcopal Church, a 32nd degree Mason, and a member of the Mystic Shrine. His clubs are the Indianapolis Athletic and Columbia Clubs, the Woodstock Country Club, and the Gibson Island Club, Maryland. He is also a member of the Society of American Military Engineers and a Fellow of the American Geographical Society.



Drawn by Logan U. Reavis especially for Scientific American. Approved by U. S. Navy

Battleship Types of Three World Powers

The comparisons of the three heaviest existing capital ship types of England, Germany, and the United States, given in the above drawing, indicate that the performance of the new *North Carolina* type may be awaited with confidence: in design, fire-power, and maneuverability it may, in some future encounter, justify the extraordinary care which has been exercised in its construction.

Resembling its ill-fated sister ship, the *Bismark*, it is probable that the *Tirpitz* is closer to a displacement of 50,000 tons than to the 35,000-ton figure usually assigned to her. Although the *Prince of Wales*, sister ship of the *King George V*, was somewhat punished by the *Bismark*, and later sunk by Japanese planes, it does not necessarily follow that this class is weaker than the *Tirpitz* under similar conditions. Theoretically the *King George V* has the advantage of later research.

DREADNOUGHTS OF THE U. S. NAVY

A Two-Ocean Fleet is Our Nation's Ultimate Goal

WALTON L. ROBINSON

Everyone realizes that the bitter conflict between the United States and Japan, particularly in its early stages, will be fought largely at sea and in the air. There has been and will be hard fighting on land, but before American and Japanese soldiers can come to grips on the battlefield they must first be embarked in transports and safely escorted by warships to the scene of operations. Seapower, from the very start, has played an even more decisive role in the Southwestern Pacific than it has thus far in European waters.

For the past several years the United States Navy has been undergoing a rapid expansion toward its ultimate goal—a two-ocean fleet capable of repelling any likely combination of hostile powers in both the Atlantic and Pacific. This expansion continues at an ever-increasing pace, but now that war is actually here we must place our reliance in those ships which, fully manned by trained officers and men, are in every respect ready for active service. Warships in the blueprint stage or on the building ways never won a naval battle.

Early in December last, 17 American battleships, displacing 534,000 tons, were in commission, giving us the largest, though not the most up-to-date dreadnought force in the world. Between them these ships mounted 178 heavy-caliber guns having a total broadside weight of 277,640 pounds. Five of our ships were armed with 16-inch guns, eleven with 14-inch, and one with 12-inch. Great Britain followed with 13 battleships and two battle cruisers; while Japan, third largest of the world's sea powers, had 12 capital ships of some 385,000 tons and carrying 114 guns with a combined broadside weight of 186,460 pounds. Four of Japan's ships were armed with 16-inch guns and the remainder with 14-inch. The Imperial Navy also possessed three or four "pocket battleships" displacing around 15,000 tons and mounting six 12-inch guns each.

Mere statistics, however, cannot give an accurate picture of the relative fighting value of the American and Japanese battle fleets, for they fail to take into consideration such important factors as age, speed, armor protection, and hitting power of individual ships and the ability of each to operate in effective conjunction with the others. Our three oldest battleships are, for example, of very doubtful value, due primarily to their low speed and limited gun range, while several of Japan's are so scantily armored that a few hits from large caliber shells would certainly put them in serious trouble.

NATIONAL DEFENSE

■ This thorough-going analysis of battleships of the United States Navy is the first of a series of five articles, each complete in itself, which will give an accurate over-all picture of our naval strength in surface ships and submarines. *—The Editor* ■

Our battleships range in size and age from the 26,100-ton *Arkansas*, completed in 1912, to the giant 35,000-ton *North Carolina* and *Washington*, which passed into service last year. Fifteen new battleships are completing afloat, building on the slips, or authorized. Several may be ready by the end of this year.

The *Arkansas*, our oldest and least valuable dreadnought, was built as a sister-ship to the *Wyoming*, which some years ago was demilitarized in accordance with the London Naval Treaty of 1930 and converted into a training ship. The *Arkansas* carries a main armament of twelve 12-inch guns mounted in six turrets disposed along her center-line. These guns, measuring 50 feet from breech to muzzle, hurl an 870-pound projectile at an initial velocity of over one-half mile per second. Due to their very limited elevation (15 degrees), however, they have an effective range of only some 15,000 yards, which is far below current requirements; and the *Arkansas*, were she to encounter a modern cruiser, might well find herself unable to get within range of her harder-hitting guns while, at the same time, suffering numerous hits from the cruiser's lighter but longer-ranged weapons.

The *Arkansas'* secondary or anti-torpedo armament consists of sixteen 5-inch, 51-caliber guns. These guns, firing a 50-pound shell, are of fairly modern design and constitute the secondary armament of all our battleships except the two newest. The anti-aircraft battery comprises eight 3-inch and numerous smaller guns. The 3-inch gun is inadequate for today's needs and in most of our battleships has given way to the more effective 5-inch, 25-caliber weapon.

Armor protection includes an 11-inch main belt along the water-line, 12-inch plates on the faces of the big-gun turrets, a 12-inch conning tower, and fairly thick decks over such vital spots as the engine and boiler rooms and shell and powder magazines.

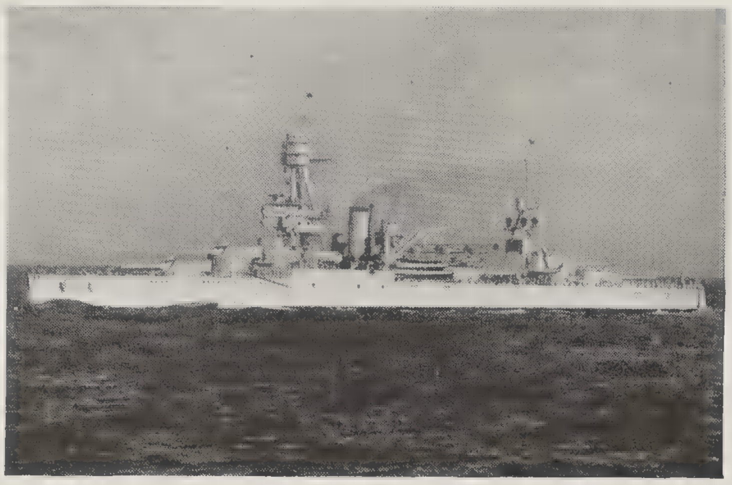
The *Arkansas* was designed to attain a speed of 20.5 knots, but can now do no better than 19 knots. This reduction was caused by the addition of anti-torpedo "blisters" when the ship was modernized some 15 years ago. Other alterations effected at this time included conversion to oil burning, stronger anti-aircraft defense, substitution of a tripod mainmast for the old cage or basket mast, and improved plane-handling arrangements. Three aircraft and a catapult are now carried atop No. 3 turret.

The *New York* and *Texas*, launched in 1912 and completed two years later, are our next oldest battleships. They displace 27,000 tons and are armed with ten 14-inch guns mounted in five center-line turrets. These guns are 45 calibers in length (that is, 52 feet, 6 inches), elevate to 15 degrees, and fire a 1400-pound projectile at a range of some 21,000 yards. Their secondary and anti-aircraft batteries are the same as those in the *Arkansas*. Armor protection includes a 12-inch water-line belt, 14-inch turret faces, thick decks, and a 12-inch conning tower. Anti-torpedo blisters, fitted some years ago, have reduced their speed to about 19 knots. Three planes and a catapult are carried on the amidship turret.

These ships are hard to handle and very poor sea boats in rough weather; they roll so badly, in fact, that waves frequently ride the blisters into the 5-inch gun casemates. One of the most interesting features of their design is the reversion to reciprocating engines in place of the turbines which had been fitted in the *Arkansas* and other earlier ships. This was done to show American turbine builders, who had refused to adopt the standards laid down, that the Navy Department was determined to have turbines built to official specifications.

The *Arkansas*, *New York*, and *Texas* are the "lame ducks" of our fleet and are no longer reckoned effective for war purposes. Judged by modern standards they are now quite obsolete and of little value as "line-of-battle" ships. Their presence in a major engagement might well prove a liability rather than an asset to our commander in chief, for their low speed and the limited range of their big guns would make it extremely difficult for them to operate with our faster and more powerful ships. Despite their deficiencies, however, these old battleships can still perform such secondary tasks as escorting convoys and attacking coastal objectives. They are hopelessly outclassed by Germany's trio of modern 30-knot battleships: the 35,000-ton *Tirpitz* (eight 15-inch guns) and the 26,000-ton *Scharnhorst* and *Gneisenau* (nine 11-inch guns).

The 29,000-ton *Nevada*, commissioned in 1916 as a sister ship to the *Oklahoma*, which capsized in Pearl Harbor last December 7, carries the same main armament as the *Texas*. Her 14-inch guns are differently arrayed, however, being grouped in two twin and two triple turrets with the former in the super-imposed positions. Moreover, they elevate to 30 degrees and have a range of some 30,000 yards. The *Nevada's* secondary and anti-aircraft batteries consist respectively of twelve 5-inch, 51-caliber and eight 5-inch, 25-caliber guns, plus numerous smaller weapons. She also carries three planes and two catapults—one on No. 3 turret and one on the quarter deck. Her secondary and anti-aircraft batteries and plane-handling arrangements are standard for all of our remaining battleships except the new *North Carolina* and *Washington*.



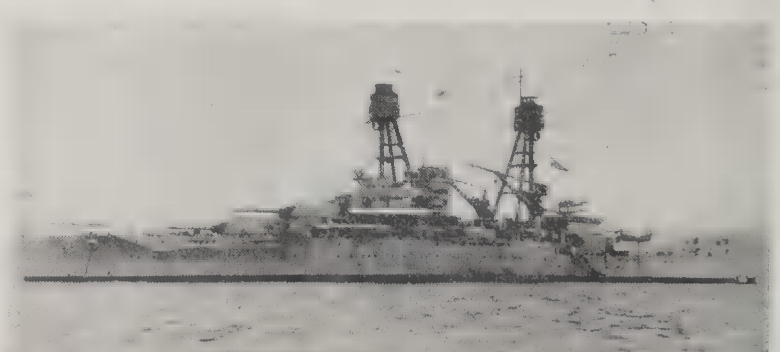
USS *Texas*, useful in convoy work

The *Nevada* and her ill-fated sister-ship marked a new era in naval construction, being the first dreadnoughts to embody the "everything or nothing" principle in the matter of protection. A $13\frac{1}{2}$ inch belt, 400 feet long and $17\frac{1}{2}$ feet wide, protects the water-line, 16- to 18-inch plates cover the turret faces, 16 inches encase the conning tower, and 3-inch upper and 2-inch lower decks provide defense against aerial bombs and long-range plunging shellfire. All this protection, less the horizontal or deck armor, weighs nearly 8000 tons.

The *Nevada's* designed speed of 20.5 knots, obtained by Parsons turbine engines developing 25,000 horsepower, was unaffected by the $7,000,000 modernization she underwent some years ago. The addition of anti-torpedo blisters, however, has made her unwieldly at low speeds. She and the *Oklahoma* were the first American battleships to be fitted with all-oil-fired boilers.

The *Pennsylvania*, launched in 1915 and completed the following year, is a sister-ship of the *Arizona*, which sank in shallow water at Pearl Harbor. Displacing 33,100 tons, the *Pennsylvania* is simply an enlargement of the *Nevada*, which in appearance she greatly resembles. She has two more 14-inch guns, heavier armor protection, and a somewhat higher speed. The increase in the number of big guns was made possible by placing three of them in each of the four turrets. The water-line belt is 14 inches thick and two decks, a 6-inch upper and a 3-inch lower, protect the ship's vitals. The speed of 21 knots is obtained by 32,000 horsepower turbine engines driving four screws.

The *Pennsylvania* is a splendid sea boat, offering a very steady gun platform, and has proved a most economical steamer. She has always been regarded as a fine ship and for many years served as flagship of the CINCUS (Commander in Chief, United States Fleet). Some years ago both she and the *Arizona* underwent an extensive reconstruction at a total cost of nearly $15,000,000. Among the alterations effected were the raising of the anti-torpedo battery from the main to the upper deck, the strengthening of the anti-aircraft armament, substitution of tripod masts for the old cage type,

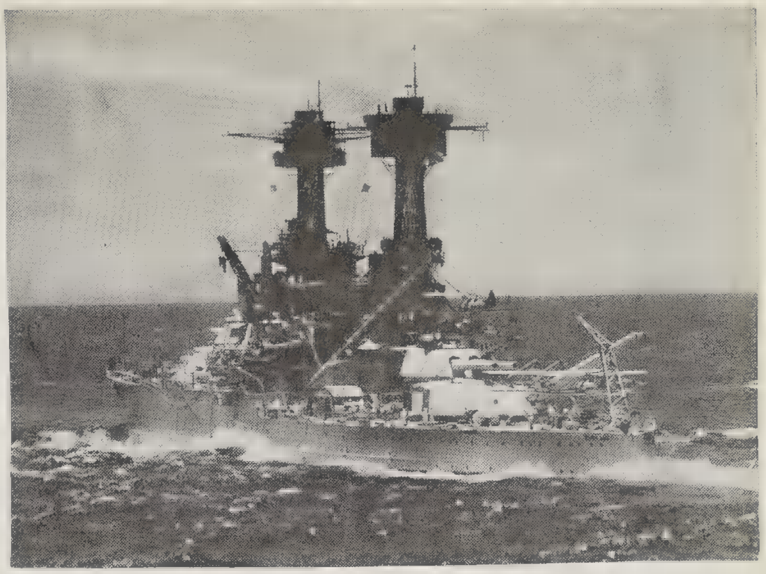


All illustrations Official U. S. Navy Photographs

USS *Arkansas*, our oldest dreadnought

USS *Nevada* marked a new era in naval construction

USS *Idaho* has been completely modernized



USS *Maryland* has not been modernized

addition of blisters, and the improving of the internal sub-division.

Between January and June, 1917, three fine ships, the *New Mexico*, *Idaho*, and *Mississippi*, were launched. As originally built they were slight improvements on the *Pennsylvania* design, but a few years ago they were so completely modernized that they may well be regarded almost as new ships. They are now the fastest and most stoutly protected of our older battleships and, everything considered, more formidable ships than the newer *California* and *Tennessee* and three *Marylands*, none of which has been modernized. Averaging just over 33,000 tons, the *New Mexicos* carry twelve 14-inch guns, have a 14-inch main armor belt, 18-inch protection for the big-gun turrets, minute internal sub-division below the water-line, and two decks (6-inch upper and 4-inch lower) over vital areas. Their 14-inch guns, of a more powerful model than in preceding ships, elevate to 30 degrees and have a maximum range of over 35,000 yards or some 20 miles.

One of the most noteworthy features of these reconstructed ships is their relatively high speed of 22 to 23 knots, obtained by 40,000 horsepower Westinghouse geared turbine engines. The *New Mexico* has four White-Forster boilers and the other ships six of the Bureau Express type.

The *California* and *Tennessee*, launched in 1919, are slight improvements over the original *New Mexico* design. They were scheduled for modernization during 1940-41, but the Navy Department cancelled the work because of the threatening international situation—just a case of keeping the powder dry. Displacing over 32,000 tons, they have the same armament and vertical protection as the *New Mexicos*, but are not as stoutly armored against air attack, having decks only 3½ and 2½ inches thick.

These two ships are equipped with electric drive. Power for their four alternating current motors, one to each propeller shaft, is generated by turbines—General Electric in the *California* and Westinghouse in the *Tennessee*. Designed speed is 21 knots, which was reached on trials.

The *Maryland*, *Colorado*, and *West Virginia*, launched in 1920-21 and displacing from 31,500 to 32,500 tons, are almost identical to the *California* except for their main armaments of eight 16-inch guns and a 2-inch increase in the thickness of their waterline belts. The 16-inch guns, 45 calibers in length, elevate to 30 degrees and hurl a 2100-pound shell at a maximum range of over 33,000 yards.

USS *North Carolina* can just barely squeeze through Panama Canal locks

The *North Carolina* and *Washington*, launched in 1940 and costing nearly $70,000,000 each, are our newest and finest dreadnoughts. They are larger, faster, more powerfully armed, and more stoutly protected than any of our older ships and utterly different in general design and appearance. With their length of 750 feet, their beam of 108 feet, and their draught of 36 feet they can just barely squeeze through the Panama Canal locks. Their designed speed of 28 knots is obtained by geared turbine engines.

Their armament consists of nine 16-inch guns mounted in three heavily armored turrets, plus powerful secondary and anti-aircraft batteries. The 16-inch guns, of a new and very powerful model, have a range of about 40,000 yards. Two catapults and several planes are carried on the quarter-deck. These two ships are unique in having no portholes along the hull, ventilation and lighting being entirely artificial.

Work on four additional units of the *North Carolina* class is now being pushed as rapidly as possible. Three of them, the *South Dakota*, *Massachusetts*, and *Indiana*, begun in 1939, were launched last year and may be completed in time to join the fleet the latter part of this year. The fourth ship, the *Alabama*, launched this past February, will not be ready before next year. These ships will constitute a powerful reinforcement to our fleet and give us a definite superiority over the Imperial Navy. Our main battle fleet, composed of the six *North Carolinas* and the eight units of the *Maryland*, *California*, and *New Mexico* classes, should then be strong enough to take the offensive.

We Need More Physicists

Military Activity and Industrial Requirements Have Created an Unprecedented Demand

E. U. CONDON, Ph.D
Associate Director, Westinghouse Research Laboratories, East Pittsburgh, Pennsylvania

EVERYONE has heard of the science of physics, embracing our fundamental knowledge of the forms of energy—mechanics, acoustics, electricity, magnetism, heat, and radiation. And everyone realizes that the science is basic to every phase of our industrial activity. But how many of us know a physicist or have any conception of what he does?

The word "physicist" was seldom seen in newspapers until recently. Now these same news sources tell of a drastic shortage of professionally competent physicists, which shortage is leading to all sorts of emergency rush training programs. Asked by the editor of Scientific American to explain in what way physicists are essential to the war, I had, of course, to reply that this could be done only in the most general terms, since specific details of such war work are in the secret classification.

He replied that even so he felt that many people are quite uncertain about the distinction between physicist and engineer; that it ought to be possible to discuss their work in a way which would help the general understanding and especially would aid students in their choice of a career.

Until quite recently, the opportunities for physicists as such were almost entirely confined to college and university teaching. In the better universities this offers an attractive career, for with the work of teaching it combines facilities and a favorable environment in which to carry out research—to adventure in the unknown frontiers of knowledge with a genial band of like-minded explorers.

However, in the lesser colleges and universities the picture is not so attractive. In them the libraries and laboratories are usually inadequate for truly fundamental research, and the arrangements are such that the professor has so much teaching to do that he has very little energy left for original investigation.

In any case, the total number of positions available in university teaching is not great enough to support a very large number of physicists. Fewer than 3000 physicists find employment in this way in the entire United States.

Dr. Condon

In recent years, however, a rapidly increasing number of physicists have found employment in industry, first and still mostly, in research laboratories, but also in engineering and production units as well. Now everybody thinks he knows the difference between a professor and an engineer. But when a physicist works with engineers in an industrial organization this question arises: What is the difference, if any, in their function, and on which kinds of work should one use the physicist and which the engineer?

The difference in them, by which we shall decide which label applies, is that the physicist elected physics as his major study, usually in a liberal arts college, whereas the engineer studied one of the recognized specialties, such as electrical engineering, in an engineering college. Another difference is that most physicists have continued university work beyond the bachelor's degree, gaining thereby some training in independent original research methods. On the other hand, it is much more usual for the engineer to leave the university on graduation from a four-year course and to go at once into industrial employment.

This difference in training manifests itself in a difference in approach to a given problem which is approximately described by saying that the engineer is a conservative and the physicist a radical about new scientific developments. The engineer works best on the careful economic development of some applied science project whose general practicability has already been demonstrated. The physicist works best when trying to understand some newly-observed phenomenon that nobody as yet understands at all, or when trying some totally untried combination of ideas to get a new device of which

Some basic research must continue despite the war, for when peace comes we will have vast amounts of excess materials and the public demand for luxury items, long held in abeyance by military production, will come back

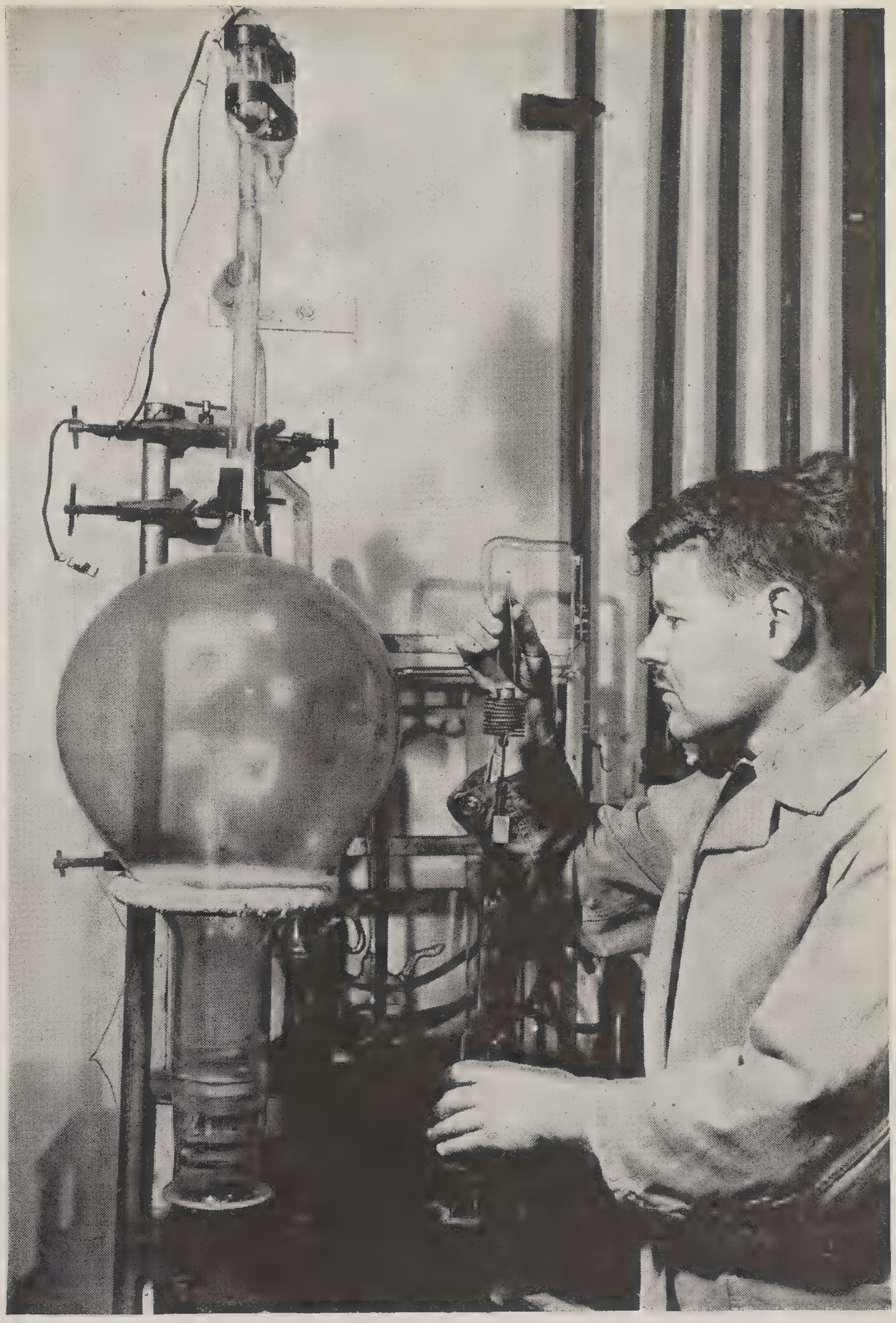
nobody is sure that it will be practical or even if it will work.

To any such broad generalization there are, of course, plenty of exceptions. Naturally, there are many scientifically radical engineers, just as there are some mighty conservative physicists. Here we are not trying to place a higher valuation on one type rather than the other: obviously both types are needed. As in other fields of endeavor, it must be noted that the conservatives and radicals often have difficulty understanding each other's view-point, even to the point of being sometimes mistrustful of each other.

But, anyway, it works out like this: The physicists are always busy looking into things in the physical world without much regard to their utility. In this way they are always aware of a lot of interesting phenomena which have not yet found, and may never find, any practical application, and they are trained in the art of digging up more such phenomena. The engineer, on the other hand, is busy with making important improvements and better application work in fields already established. Hence if a radically new device, or a radically new solution to an old problem, is needed, it is better to put a team of physicists on the job than a team of engineers. If nothing of the kind proposed has ever been done before, you are more likely to get it done (if it can be done at all) by physicists than by engineers.

THE device you get from the physicists as a rule will not be very well designed either for reliability of operation or simplicity of manufacture. When the engineer sees it, he is apt to sniff contemptuously unless he is an unusually broad-minded fellow. But he should not be too intolerant, for the chances are, if it is a really new device, that he does not know the new principles which it utilizes or at least is not familiar enough with them to have thought of applying them. After the physicist has made such a laboratory model, it is up to the engineer to make an engineering design, in the course of which many detailed improvements will be made, before the device can be put into production.

With this picture in mind it ought to be clear why physicists are so very valuable in preparations for modern mechanized war. The Services want devices for locating enemy planes or submarines, or for exploding bombs under special circumstances, or for protection against magnetic mines, or for fire control purposes, and so on. If it is a device of a general kind which they already have, they can get improvements and production designs by turning the job over to a team of engineers. But if it is a device that is completely unknown—simply an idea for a device which would be tactically valuable if it worked—then a team of physicists is called for as being most likely to produce the device . . . if it can be done.



We will know more about metals after the war is over; research metallurgists are working as never before in their search for metal substitutes

Our research preparedness activity on a large scale really dates from May, 1940, with the appointment of the National Defense Research Committee. By early autumn of 1940 the NDRC had decided on its main plan of action. Soon the best physicists of the country were organized into special teams and put to work applying the latest discoveries of the pure science laboratories to the solution of problems presented by modern warfare. It is fortunate indeed that the work was started this early—or rather most unfortunate that it was not started still earlier—since any new development of major importance calls for a tremendous amount of effort even before it is ready to be "engineered." Nevertheless, it can be said that several devices of great importance which have resulted from these efforts are already in production and many more may be expected soon.

Naturally, this "conversion" of the physicists has not been accomplished without completely upsetting their "business as usual." Up until recently their main concern had been the study of the great new field of atom-smashing

or nuclear physics. Even a year ago nearly all of this fundamental research had come to a stop because of the demand for trained physicists to do war work. For example, our large four-million volt generator at the Westinghouse Research Laboratories has been shut down for months—not because this field of science is thoroughly explored or less significant, but simply because of the importance of the war job. The only cyclotrons operating now are those that are being used to prepare artificial radio-active materials for medical research.

I first discovered Scientific American when I was about 14 years old, and reading it greatly influenced me in getting a clear notion that I wanted to do research in science. Knowing that this magazine must be playing a similar part in the lives of boys today, I would like to close with a little advice to them.

Industry and science are being linked together by this war more closely than ever before. During the present war new advances in applied physics are being made which have brought about an urgent demand for young men with sound scientific training. Any boy who has a real aptitude for scientific studies cannot serve his country better than by devoting his best efforts to learning as thoroughly as he can and as quickly as he can and as much as he can about mathematics, physics, and chemistry. He should not scorn the "theoretical" fundamentals for hastily-gained superficial "practical" knowledge.

It is a great misfortune that many of the administrative officers of our public high schools have failed to appreciate the importance of sound training in fundamental mathematics and science. The quality of mathematical instruction in the high schools has sagged steadily in the past 20 years to such an extent that even the boy who gets an "A" grade in mathematics has a poor foundation on which to build his future work in science. No doubt the war will soon focus attention on this sorry state of affairs and reforms may result, but, in the meantime, boys who really want to help in this war should set themselves higher standards of mathematical attainment than most teachers demand.

Not only can the boy who has a real aptitude for science find a great opportunity to serve in the war, but with the steady advance in science-mindedness in all industry, it is safe to assume that the opportunities for scientific research in post-war industry will be much greater than ever before.

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DELAYED JUMP

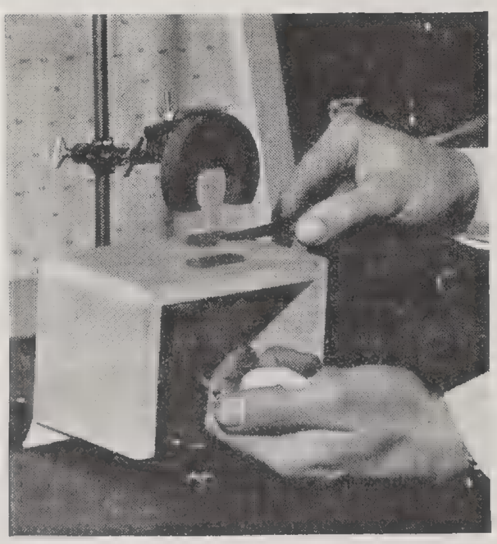
Of Strip to Magnet Demonstrates Atomic Change

A steel strip that, when placed under a powerful magnet, waits about a minute and a half before it jumps toward it, is the demonstration used by Dr. Herbert H. Uhlig, of the General Electric Research Laboratory, to show a delayed change in the strip's atomic arrangement. Exact knowledge of the nature of such changes is important in making magnetic materials for transformers and other electric equipment.

The strip used in the demonstration is a common type of stainless steel containing 18 percent chromium, 8 percent nickel, and the rest iron. This metal, known as 18-8, is not ordinarily attracted by a magnet, because it usually contains a little nitrogen. The nitrogen seems to cause friction within the metal, which prevents the atoms from rearranging themselves to the phase in which a magnet causes attraction.

If, however, the same type of stainless steel is made nitrogen-free, it takes on other properties; the demonstration strip is a piece of such nitrogen-free metal. When the strip is heated to a temperature of 1100 degrees, Fahrenheit, it again loses its magnetic property. This property does not return until the strip is cooled down to the boiling point of water. Dr. Uhlig, however, found that if the heated strip is suddenly cooled by quenching in ordinary tap water, and then placed under a magnet, it is not attracted, even though it is cooler than the temperature at which the change in the magnetic property of the metal should occur.

After about a minute and a half,



Time needed for atomic rearrangement is demonstrated magnetically

however, it suddenly jumps to the magnet. Dr. Uhlig says that the atoms start rearranging themselves as soon as it is cooled, but it takes this time before a majority are shifted and at least a day before all reach a state of equilibrium.

The change is one in the crystalline structure of the metal. At the high temperatures, when non-magnetic, it has the face-centered arrangement, with the atoms forming cubes piled like bricks. The low-temperature magnetic phase has them in the body-centered arrangement, with cubes interlocking, so an atom in the center of one forms the corner of adjacent cubes.

"From these experiments," said Dr. Uhlig, "we hope to learn more about the heat treatment of steels and the preparation of alloys with better mechanical properties and corrosion resistance."

EYES

Are Most Sensitive Light Recorders

Proof that the eye is one of the most sensitive of all devices for recording light—far more sensitive than the best photographic emulsion or any other physical apparatus—was presented recently by Dr. Selig Hecht in reporting the first experiments to measure precisely the smallest amount of light which the eye will record.

According to Dr. Hecht, professor of biophysics at Columbia University, from five to fourteen quanta (a quantum is the smallest, basic, and indivisible unit of radiation, including light) will make an impression on the retina of the eye, thus leaving only a scant four smaller amounts of light which the eye is incapable of perceiving. He reported that for half a dozen observers, over a period of several months, the minimum energy necessary for vision was observed to be between 2.2 and 5.7 ten-billionths of an erg. This amount, he said, represents between 58 and 148 quanta of light emitted from the apparatus.

Most of this light is lost, however, through reflection by the cornea (outer shell) of the eye, absorption in the lens and other parts of the eye, and passage through the retina without absorption, Dr. Hecht pointed out. Subtracting this lost light, the amount actually absorbed by the retina is five to fourteen quanta, he said, adding that since each quantum reacts with only a single molecule of the receiving substance of the retina, as few as five molecule changes would produce light impression.

Have You Heterophoria?

Eye Exercises Using New Light-Polarizing Vectographs Can Improve Depth Perception

EVERETT WHITE MELSON

Don't be shocked if an optical test reveals some day that you have heterophoria. According to some of our best eye authorities, this condition exists in about 80 percent of the eyes examined. Ordinarily, a mild contraction of the muscles that move the eyeball always exists. This is because the brain is attempting to fuse the images from each eye. It sends nervous impulses to the muscles to persuade them to pull a little more here or a little more there until the images appear on corresponding areas of each retina.

If there is a lack of balance in these eye muscles, one eye, or both, may be deviated so that the images appearing on the retinas cannot be fused and the binocular function of the eyes is lost. This function is most valuable, since it gives us depth perception, enables us to estimate distances, and provides us with contrasts and comparisons.

Heterophoria means that, due to some form of deviation of the eyes—one turning inward, outward, upward or downward—we cannot secure this binocular vision. We have to depend upon one image from one eye and thus lose the ability to judge distance and depth. Frequently this deviation is so obvious that anyone can see it, as in cross-eyes. More often, however, it is not apparent to an unskilled observer and the one who has it may be totally unconscious of it. In many cases there is no pain or discomfort. In other cases it is quite distressing, particularly in close work. One of its worst features is that it may drift into such conditions as amblyopia exanopsia, in which the vision of one eye dims from lack of use. This particular condition is generally agreed to be acquired and not congenital, and it can be cured.

If you have ever observed a baby's eyes you may have noted that many of their movements are not coördinated. He uses them independently, largely because the brain has not been trained by experience to evaluate objects and to demand a fused image. He will reach for a bottle or a rattle and miss it by several inches. When the brain begins to demand a fused image, one group of muscles becomes active in aligning the eyes for coördinate work while another set shapes the lenses to focus the objects. These acts of convergence and accommodation are to a great extent acquired faculties. That they are acquired faculties, subject in a large measure to voluntary control, is evidenced by the fact that most people can converge or rotate the eyes at will.

It is not enough that images shall be formed on corresponding areas of the retinas. They must be symmetrically distributed around the fovea, a tiny depression in the center of the macula. The fovea and the macula have a great number of little cones, or photo receptors, which are extremely sensitive to both detail and color. Further, the two images must be similar in size, shape, and alignment in order to be capable of fusion. Since the two images are formed at a slightly different angle, due to the spacing of the eyes, they are slightly different—just enough different, in fact, to create the sense of depth when they are superimposed. If they are not similar in size, shape, or location, a double image will result and the brain will be forced to suppress one image in order to see the other clearly.

Exercising at leisure

To orientate both eyes for the production of images on the macular areas, the six muscles that move the eye in its orbit must act in concert, some contracting and others relaxing. These are known as conjugate movements because these muscles are linked together by the nervous system. Likewise, the ciliary muscles, which are responsible for accommodation, are busy increasing or lowering the convexity of the lens so that objects can be sharply focused at varying distances.

Defects in the refractive system of the eye can be corrected by proper glasses, and imbalances in the muscles that move the eye are frequently corrected by the introduction of prisms to offset the deviation, but since the action of these muscles is subject to voluntary control, it is possible to provide them with a system of calisthenics to improve their coördination, thus improving the overlap in the retinal images and resulting in better depth perception.

It has been said that in some ways it is better to have one blind eye than two eyes in one of which vision is temporarily suspended, as is frequently the case in a deviation of one eye. The one-eyed person has two possible errors eliminated automatically—affections of symmetrical movement of the eyes, and image differences. On the other hand, his sense of perspective can be only moderate since he must rely on the one good eye. Some people, however, who have suffered the loss of vision in one eye at an early age have developed better judgment than their fellows who have defective binocular fusion, because the latter can be very dangerous in many occupations.

In nearly all cases of faulty fusion faculty there will be either a tendency to suppress the more disturbing image of the two—resulting in a dimunition of vision—or to cultivate a squint in an effort to shift the more disturbing image out of view. The latter may be unsightly, but at least the obvious defect may lead to early corrective efforts.

Usually, in cases of heterophoria, whether in children or adults, the patient complains of difficulty in close work as the chief symptom. If all refractive errors — irregularities in the transparent media of the eye—are corrected, a vast improvement can often be effected by proper exercises.

Occasionally, psychological cases are discovered, such as the one of a clerk, 30 years of age, doing close work and suffering from eyestrain, who was given a series of exercises to correct deviation. He obtained a full range of fusion but his symptoms were no better. The fact was elicited that he hated his job and wanted to be an engineer but lacked the initiative to set about it. In this case, cure of the condition did not produce disappearance of the symp-

Specially prepared for Scientific American by Mr. Melson, of Bausch & Lomb Optical Company.

***Left:* How a vectograph transparency looks to the unaided eye and, *right*, when objects are fused**

toms, as might have been expected.

In another case, a woman lawyer, aged 28, complained of eyestrain when reading or driving a car. She refused to be bothered with exercises and was not seen again for ten years, when she reported no symptoms whatever. Examination showed that several diopters of deviation outward still existed, with no voluntary convergence. In the meantime, however, the woman had married and had children. She was no longer worried and said she could read and drive with comfort. This is a case in which the symptoms disappeared with the patient's greater sense of security and life fulfillment, although the condition remained unchanged. These cases are in the minority, however, and most of those who realize their deficiency are willing to make the necessary effort to improve their sight.

The branch of optical science which specializes in developing the coördination of the visual apparatus in muscular deficiencies is known as orthoptics. It involves the use of a number of training instruments, lenses, prisms, and sometimes light therapy. In general, the patient is required to visit the doctor's office to take the treatments, since many of the instruments are large and complex and the exercises must be supervised and progress measured.

In the effort to provide a method of home training, under the doctor's supervision, a new device has recently been introduced by the Bausch & Lomb Optical Company which utilizes a carefully graded set of photographs which are viewed through polaroid lenses to train the eyes and exercise the muscles both in convergence and accommodation.

This device, known as an ortho-fusor, consists of a group of pictures made by the vectograph process of Edwin H. Land. It permits two complete and distinct pictures to occupy the same place at the same time, without distortion of tone, loss of detail, or interference with each other. To the naked eye these pictures appear flat and fuzzy, but they are transformed into lifelike reproductions when viewed with polaroid glasses. As thin as paper, the pictures appear as deep as the original scenes themselves.

In conventional photography, pictures are rendered in terms of the density of distribution of the tiny silver particles in the emulsion. In the new process used in the ortho-fusor system, they are rendered in terms of variation in the polarizing characteristics of the transparent sheets on which the pictures are printed.

The two views necessary for recreating the sense of depth are taken with a camera equipped with two lenses as far apart as the eyes. The pictures are taken on regular film and developed in the ordinary way. It is in the process of making reliefs or transfer films from these negatives that the introduction of two pictures in the same film is worked out.

The two pictures are first made into relief images, in which the picture exists as variations in thickness of a gelatine surface, thicker for dark parts of the picture, thinner for light parts. This relief film is used as a sponge to apply a chemical reagent to the final vectograph film.

This film has an invisible optical grain which runs in different directions on the two sides, as in a piece of plywood. When the relief films, soaked with reagent, are pressed against the vectograph film surfaces, the reagent combines with the vectograph film to form light-polarizing images; completely polarizing where the picture is to be dark and only slightly polarizing where the picture is to be light.

In the finished vectograph, two images are superposed, one on each side of the film. The picture thus appears blurred to the naked eye. The polaroid viewing glasses have the optical grain of each lens set in such a way that each develops the full contrast of one of the two images and makes the other invisible. Each eye sees the picture intended for it, as in normal vision.

The pictures comprise a variety of scenes. Boulder Dam, with its abutments, spillways, and generating station, makes a good subject. Others are an Indian squaw weaving a rug; a girl picking flowers; a famous Canadian cathedral. Around the borders of these pictures, cubes and other objects are arranged so that the eye follows them in a complete rotation while the head is held in a fixed position. Some of these objects are easily fused, others with greater difficulty.

The ortho-fusor is, of course, no substitute for glasses since the refractive media of the eye, such as the cornea and crystalline lens, must be corrected. With any necessary optical corrections made, exercises to improve the coördination of the extrinsic muscles—those that move the eye in its socket—may be undertaken under the advice of an oculist or optometrist. The small ortho-fusor kit, which contains the vectographs required for such exercises, may be carried in the pocket and used whenever a spare moment is available. Thus the heterophoria sufferer may take his exercise frequently and at convenient times, hastening full return of true binocular vision and all its desirable features.

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SULFANILAMIDE

Why the New Drug is "Unfair to Bacteria"

New research confirming earlier evidence that sulfanilamide attacks bacteria by literally starving the germs may provide a hopeful method of making drugs to order for specified germs.

Until recently, pharmacologists, the scientists who develop new drugs, have worked mainly on a hit-or-miss basis. Ehrlich, for example, tried 606 times before he hit on salvarsan, the specific drug for the organism of syphilis.

The new research is reported in *The Lancet*, British medical journal, by Dr.

Sydney D. Rubbo and Dr. J. M. Gillespie, of the University of Melbourne, Australia. They found that p-aminobenzoic acid is needed by a certain type of bacteria for growth. This acid is similar in its chemical structure to sulfanilamide. When the sulfanilamide is present, the bacteria are tricked into using it instead of the necessary acid. Since sulfanilamide does not promote growth, despite the similarity in chemical structure to the acid, the bacteria cannot develop.

However, only one part by weight of the acid will offset the growth inhibitory qualities of 26,000 parts of the sulfanilamide. This is a possible explanation of why such large amounts of the drug are needed in treatment of bacterial infections.

ANTIBODIES

Just How Do They Perform Their Half-Mysterious Work?

THE possibility of made-to-order or custom-built substances synthesized premeditatedly to curb definite germs, recently has become more prominent as a result of studies by Dr. Linus Pauling of the California Institute of Technology.

He has been concerned with natural types of protective and life-saving substances found in the body—the so-called antibodies. When a person is attacked by typhoid or diphtheria germs, to choose two familiar cases, it is the chemical products of these invaders which cause the disease symptoms. The body fights these injurious substances, which are of albumin or protein character, by preparing special proteins of its own to destroy the foreign ones.

The amazing thing about the antibodies is their specific action. They are essentially the same proteins normally present in the blood—the chemist has not yet been able to show any difference between them. Yet these antibody proteins in the blood of a diphtheria or typhoid patient have a tremendous ability to destroy poisons which the almost identical normal blood proteins totally lack.

Dr. Pauling has developed preliminary tests in an attempt to do what has never been done before—synthesize disease-curbing antibodies in the laboratory. The work is based on the scientist's important studies of protein structure.

Proteins are made up of huge molecules many tens of thousands of times heavier than hydrogen. The atoms composing these molecules are arranged roughly as a long chain with numerous short side branches, and the whole chain is coiled up on itself to form a compact, ultramicroscopic, roundish mass. Dr. Pauling believes that the differences between various antibodies and the blood proteins with which they are so nearly identical, is only in the way the chain has become folded on itself.

The California researcher uncoiled the molecules of a selected blood protein by using known substances that would do the job. Then to the solution he added another chemical. The straightened-out protein chains gradually folded up again, but this time they folded in a particular way, using the molecules of the newly added material as molds about which to coil. According to Dr. Pauling, this process resembles what happens when normal body proteins are formed in blood contaminated by the molecules of diphtheria-germ poisons.

The specific action of antibodies may be the result of blood protein molecules which mold themselves to various disease poisons and neutralize the harmful effects. That tremendously powerful antibodies will be produced in the laboratory and a host of diseases put to rout, seems a reasonable expectation from this particular piece of research.

STUTTERING

It Starts With a Linkage

STUDY of 15 child stutterers show a neurotic family background in the majority of the cases, Dr. J. Louise Despert, of the New York Hospital and Cornell University Medical College, reports, according to *Science Service*. Nervous mothers who are always worrying about whether the baby or small child eats enough are likely to have nervous children who stutter. These stuttering children frequently have other neurotic traits.

"This is of considerable importance," Dr. Despert stated, "if one considers that the White House Conference of 1930 gave 1,300,000 as the number of stutterers in the United States and also that the majority of these cases are being treated by means of speech techniques which involve only the speaking organs and functions."

The stuttering results, Dr. Despert believes, from neurotic attention being focused on the mouth, usually with regard to the feeding situation in early years of life.

Children learn to talk at about the same time they learn to eat solid food and to feed themselves. They use the same structures to take in food and to form and pour out words. If their mother frightens them while they are trying to take in food, they are likely to be frightened also when trying to form and pour out words, and in consequence they may stutter and have difficulty in talking. The children themselves sometimes give the clue to this when they tell of their difficulty in attempting to bring out their newly formed words.

Treatment of these children consisted of general psychiatric treatment, with chewing-speaking games for the younger children or chewing-speaking exercises for the older children, in a few cases.

HOW TO RELAX

Doctors Advise Other Doctors Who Can't Sleep

THE following is from an editorial recently published in *The Journal of the American Medical Association.*

Cut down on the intensity of your thinking half an hour before retiring. (Play Chinese checkers, plan an excursion for the week end, write a letter to a friend.)

Take plenty of time to get ready for bed (next morning's clothes, leisurely bath, and so on).

If you like to read in bed, choose nonfiction or a "hard" book. Force your mind to grapple with cumbersome facts, bore it into unconditional surrender to sleep.

Transplant your mind from fears or hates to a field which has interest without excitement.

Make your mind hop from one idea to another. Just as the mind loses consciousness and sleep comes, thoughts become disjointed and scattered.

To quiet the body, get rid of any pressure or pain. (Lighten weight of covers, clothes.)

Tepid bath without a rubdown. (Get into bed a little damp and chilly. As the body becomes warmed, it becomes more and more comfortable. If during the night one becomes sleepless, throw back covers until body becomes uncomfortably chilly. Then, when the covers are pulled up again, the body once more sinks into coziness.)

Imitate the slow, deep, rhythmical breathing of sleep. (Helps regulate the circulation and may ease the mind and emotions; also tensions in the abdomen.)

Relax the muscles completely.

Get rested before trying to sleep. (Get into bed an hour or more before your regular time for retiring. Do so night after night to build up a reserve of rest and fall asleep without the old struggle.)

Astrono-Mexico

North American Astronomers Assist at Opening of Mexico's New National Observatory

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

SOME time before the entrance of the United States into the War, the Mexican Government planned an Inter-American Congress on Astrophysics, to celebrate the inauguration of the National Astrophysical Observatory at Tonanzintla, and invited many astronomers and a few physicists and mathematicians from the United States and Canada to attend it. These lines are written on the return journey from one of the most conspicuously successful scientific meetings which the writer has ever attended, and an account of the new Observatory, of the general circumstances of the Congress, and of some of the papers which were presented, is very much in order.

The Mexican National Observatory at Tacubaya, founded more than 50 years ago, has long been known for its valuable contributions to positional astronomy, and especially for its work on a zone of the Astrographic Catalogue. Situated on a low hill but a few miles from the center of the City of Mexico, it has shared the fate of Greenwich, Paris, and other national observatories. The city, growing into a metropolis of more than a million people, has almost surrounded it, and its smoke and lights interfere with certain types of observation. A new national observatory has therefore been established at a site free from present, and probable future, disturbance of this sort. It is on a little hill overlooking the village of Tonanzintla, in the State of Puebla, about 50 miles southeast of the City of Mexico and ten miles west of the city of Puebla. For miles around stretches a nearly level, cultivated plain, some 7000 feet above the sea. Twenty miles to the westward the flawless, snow-crowned cone of Popocatepetl rises 10,000 feet above the plain and to the right is the older, rugged ridge of Ixtaccihuatl, almost as high, and snowier.

The writer has for years kept a record in memory of the amenities of observatory sites, and especially the views from them—and, of the many he has seen, Tonanzintla comes first. Its only rival is the outlook from Saanich Hill, at Victoria, on the semicircle of distant snow-mountains, from the Olympics to beyond the Canadian border—unless the works of man are included, when the near view of the Acropolis from the Observatory of Athens stands alone.

From the technical standpoint, Tonanzintla is an excellent site. Its altitude exceeds that of any observatory site in the United States except Flagstaff and the new Harvard coronagraph station at Climax, Colorado. The skies are free from contamination, the climate is favorable—with rains in the afternoon in the rainy summer season—and the latitude of approximately 20° gives it an enormous advantage. The Southern Cross rises well above the horizon, and the important galactic regions, Sagittarius and Carina, get high enough for satisfactory observation.

THE principal instrument at present possessed by the Observatory is a Schmidt camera [see page 262.—Ed.] of 24 inches effective aperture, which in these clear skies will be a really powerful tool for the study of stellar distribution, space-absorption, and other galactic problems.

The Harvard Observatory has been in close association with the new Observatory of Tonanzintla and with its director, Dr. Erro, all through its organization and construction, and the installation of the Schmidt camera. In grateful recognition of this relation, the people of the village have named the street which runs up to the Observatory "Calle Annie J. Cannon," as a memorial to one of the pioneers in Harvard's astrophysical work.

The Observatory was formally inaugurated on February 17th by the President of the Mexican Republic, General Avila Camacho. The ceremony, held in the open air and favored by perfect weather, was impressive. A great crowd of people from the neighboring villages and the city of Puebla filled the slope of the hill. Behind them was a display of the massed flags (at least 200) of all American nations, from Canada to Chile, while in the distance rose the great mountains. The Governor of the State of Puebla, Dr. Bautista, made an excellent address, and the singing of the Mexican National Hymn, at the close, impressed all the delegates from north of the Rio Grande by its genuine fervor.

The Astrophysical Congress was opened, later in the day, in the hall of the University of Puebla, by President Camacho. The next morning the astronomers began three very busy days of scientific sessions at the University (whereof more later); but none of the delegates was busier than the President of the Republic, whose program for the first of these days included the inaugural ceremonies of seven institutions—schools, water-supplies, hospitals, and the like—all for the public welfare.

AFTER returning to Mexico City, the delegates were taken to Tiripetio, site of the first school of higher studies in the Western Hemisphere. In the restored hall of this ancient school, honorary degrees were conferred by the University upon four of the delegates from the north, in a ceremony of equal simplicity and dignity. [The four were Doctors Shapley, Adams, Vallarta, and the author.—*Ed.*]

The scientific sessions, as befitted the international character of the Congress, were bilingual. Every communication, whether in English or Spanish, was accompanied either by the reading of an abstract in the other language, or by a running translation at intervals of a minute or two. As always happens in such international meetings, it was not the "Norte-Americanos" who were the interpreters. A few of us were able to present our results in passable Spanish; but for fluent and accurate translation we had to depend upon our hosts.

To take a typed abstract in one language and read it off freely in another is hard enough; but several of our Mexican colleagues performed the far harder task of translating talks in English—not read from manuscript, and often including technical descriptions of slides and tables—with completeness, accuracy, and more eloquence than the original speaker could boast.

Almost 40 scientific papers were communicated to the Congress.

Adams, discussing interstellar lines, reported that the sharp lines so far observed in the spectra of distant stars have now all been accounted for. There are two lines of evidence that the interstellar gas which absorbs them is not

uniformly distributed. In the spectra of some stars, the interstellar lines of the compounds CH, CH^+, and CN are strong, compared with those of the metals; in others much weaker—while the metals are strong—showing that the interstellar gas is far from uniform in composition. Advantage was taken of this in the recent discovery of faint lines of interstellar iron, in the spectra of stars in which the lines of other more abundant atoms appear most strongly. Moreover, photographs with very high dispersion show that the H and K lines of ionized calcium are not merely double—as was discovered by Beals, in Canada, some years ago—but that in some cases there are three or even four components of different intensities. The only reasonable explanation appears to be that there are three or four different clouds of gas in different parts of the line between us and these stars, each containing calcium atoms, but moving with different velocities which sometimes disagree by as much as 20 kilometers per second.

Interstellar matter must be very patchy in distribution. This is also indicated by a report by Stebbins upon new photoelectric measures of star colors. The apparatus is now so delicate that it has been possible, with appropriate color-filters, to measure the brightness of many stars in six spectral regions, ranging from $\lambda 3500$ in the ultra-violet to $\lambda 10{,}000$ in the infrared. Very accurate determinations of star-colors may thus be made. The well known "space-reddening" of distant stars, above and beyond the color normal for their spectral type, may thus be precisely measured. The properties of the interstellar dust which produces this effect appear to be uniform, as regards the relative effects for different wavelengths, but the actual amount of absorption for stars at the same distance is very different, showing that the distribution of dust, as well as gas, is highly irregular.

An important, and previously unrecognized, function of this interstellar matter was discussed by Whipple, who showed — following Spitzer — that a cloud of such dusty gas, absorbing much of the starlight which passed through it, would be compressed by the pressure of starlight from the outside, as well as drawn together by its own gravitation, and might ultimately condense into bodies whose mass—depending on the density and other characteristics of the cloud—might range from that of an asteroid to that of a large star.

This may solve a very puzzling problem which the writer—discussing the present state of the problem of stellar evolution—had posed without answering. There is abundant evidence that the Earth, and our existing universe of stars and galaxies, is some two billions of years old, or a little more. It is well known that the stars of greatest mass and luminosity are spending their capital of available energy at such a rate that the greatest known source—the transmutation of hydrogen into helium—would keep them going for only a hundred thousand years or so. Whipple's work (corroborated by some of Spitzer's) opens the possibility that these stars may really be younger in years than the Sun. They may have existed, for most of the history of the universe, as diffuse, non-luminous masses of dust and gas, finally condensing and beginning their spendthrift careers as stars during the last few percent of the Earth's history.

Stars of the Sun's mass, however, live their lives slowly. Bethe showed, a couple of years ago, that such a star should become slightly larger in diameter, considerably hotter on the surface, and very much brighter, as its hydrogen became exhausted. In these later stages, such a star would have a spectrum of class B, but be very much smaller and less luminous, as well as less massive, than the general run of stars of this type. Few, if any, such stars have been observed. It has usually been supposed that this was because the stars passed through these stages so swiftly that there were few of them to be found there at any given time; but the writer pointed out that these stars, being bright, could be seen at large distances, which more than makes up for the time-effect. The fact that we do not find such stars (so far as our present search has gone) indicates that stars like the Sun have not had time to reach these late evolutionary stages since the present state of the Galaxy began. Incidentally, from a combination of the data of various investigators, it was shown that the known properties of the Sun can be well explained if its interior contains 51 percent by weight of hydrogen, 42 percent of helium, leaving 7 percent for all the heavier atoms—of which one tenth is carbon and nitrogen. These are rough values—adjusted to add up to 100 percent. More accurate studies —which may be hoped for in a few years—should lead to a better determination.

Several other papers dealt with the distribution and motions of stars in the Galaxy. Baker, from star-counts in Cassiopeia and Aquila, and Bok and his associates at Harvard, from similar studies of regions in Monoceros and Centaurus, find a general tendency for the star-density (that is, the number of stars in a given large volume of space) to fall off with increasing distance from the Sun—especially for parts of the Milky Way remote from its center in Sagittarius, and for stars of spectral classes near F. This is after allowance has been made for the effects of certain absorbing dust-clouds at distances of 500 parsecs and more. Mayall, from the radial velocities of 50 globular clusters—many more than have previously been observed—finds that the motion of the Sun, relative to the mean of the clusters, is in the plane of the Milky Way, at right angles to the galactic center, and at the rate of 170 kilometers a second. The first two results were to be anticipated: but the velocity is only about 60 percent of the 300 kilometers a second which has generally been adopted as representing the rotation of the Galaxy. A large number of clusters south of declination $-40°$ have not yet been observed, and cannot be until suitable equipment is put into service at some observatory in the southern hemisphere. Their inclusion may bring up the calculated velocity considerably. If it does not, we will then have to choose between two alternatives. Either the Galaxy is considerably smaller than we suppose at present, or else the system of globular clusters is rotating in the same general direction as the Galaxy, but more slowly.

To pass from far to near, two papers dealt with astronomical phenomena in the Earth's atmosphere. Elvey, from observations at the McDonald Observatory upon the light of the night sky, finds that certain lines—notably those of sodium and the red forbidden lines of oxygen—increase greatly in brightness as the first direct rays of the Sun strike the uppermost layers of the air at dawn, and fade out rapidly after they leave them at twilight. Many other radiations, such as the familiar green line of oxygen, change little at this time, but show irregular variations from night to night. These require further study, but it is already clear that they are greater on nights when the Earth's magnetism shows disturbances.

It was a first-rate conference; and every one of the delegates will agree with the writer's expression of thanks to the Mexican Government, and to the Director and staff of the Tonanzintla Observatory, for the admirable planning and emphatic success of the Congress, and for the great and unfailing hospitality which all its members have enjoyed.

—On the Mexican National Railway, February 27, 1942.

Why are We Short of Aluminum?

Huge Quantities of Electricity are Needed to Reduce this Common Metal from its Ore

HENRY W. ROBERTS

AMERICAN troops go into Surinam and Dutch Guinea to protect vital bauxite ore deposits, to assure us of enough aluminum to win the War. . . .

Aluminum is *the* vital war metal. We need it for our battle planes; we also need it for a thousand other war uses—from canteens to battleships.

Aluminum is plentiful. One twelfth of the earth's substance is aluminum. There is nothing more common in nature. And yet we are now short of aluminum. Despite last year's record production, we are still short of aluminum for our defense needs, have none to spare for our civilian needs. It takes thousands of pounds of aluminum to build a bomber, a good deal less to build a fighter plane.

Three years ago Germany produced less aluminum than either the United States or Great Britain. A year ago the United States and Great Britain, together, produced less aluminum than Germany alone. Today, aluminum production by the United Nations is running neck and neck with the Axis countries.

What do we need to outstrip the Axis in the production of aluminum? Where is the choke-point that has so dangerously slowed up our production of this vital war metal?

Aluminum is one of America's contributions to the world's industries. Discovered in Denmark, in 1825, aluminum remained a scientific curiosity until 1886 when a young American, 22-year old Charles Martin Hall, succeeded in reducing aluminum oxide to metallic aluminum by a new process which made possible commercial production of this metal.

The first aluminum which Hall produced cost eight dollars a pound. Three years later, in 1889, the cost was down to five dollars a pound. Today, aluminum costs about 15 cents a pound.

In 1934, when Germany's rearmament program had already begun rolling, the entire American aluminum industry—which then meant the Aluminum Company of America—produced only 74,000,000 pounds of virgin metal. To this was added 42,000,000 pounds of secondary metal (scrap); another 18,000,000 pounds was imported. That gave us 134,000,000 pounds in all, just barely sufficient for our normal needs during the normal years of peace.

Surface mining of aluminum ore—bauxite

By 1939, with the war in Europe obviously imminent, our production rose to 327,090,000 pounds. In 1940, with war at hand, we produced over 400,000,000 pounds of aluminum.

Last year, 1941, with war staring us in the face, we were still hopelessly short of aluminum. Including all the scrap that we could collect, our total aluminum production still fell short of the goal which was set for that year.

This year, 1942, with the aluminum industry being rapidly expanded, we should be able to produce considerably more of the virgin metal. Several million pounds may come in to us from Canada, and perhaps a like amount may be added through drives for scrap aluminum. This would give us barely enough for our 1942 military needs; still nothing for civilian needs.

What, then, is holding back unlimited production of aluminum, the most common metal on earth?

The principal source of aluminum is bauxite, a red-yellow ore rich in aluminum hydroxide. Bauxite occurs in nature in large mass deposits, usually found close to the surface of the earth. There are vast deposits of bauxite all over the world, principally in France, Hungary, Italy, Jugoslavia, Greece, Russia, British Guiana, Surinam, Netherland Indies, and the United States of America. The world's richest bauxite mines are in South America, in Dutch Guiana and Surinam. Four pounds of this bauxite make one pound of aluminum.

Control of these rich South American mines is vested largely in the Aluminum Company of America, which conducts the mining operations and maintains a large fleet of cargo ships to transport the bauxite from the ports of Moengo and Paranam, at the mouths of the Cottica and Surinam Rivers, to American and Canadian ports. More than two-thirds of all the aluminum produced in the United States is made from this South American bauxite.

One of the more serious obstacles to increasing our aluminum production under wartime conditions is the current lack of sufficient shipping which can be diverted to the transportation of additional bauxite from South America to this country.

Meanwhile, tremendous deposits of low-grade bauxite (and of another aluminum ore, alunite) were recently discovered in the United States, in our South and Southwest, but principally in Arkansas. About half of the bauxite mined in the United States goes into the production of aluminum, the other half being consumed in the production of artificial abrasives, chemicals, refractories, and insulating materials.

These low-grade Arkansas bauxite

deposits are now being commercially exploited, principally by the recently organized aluminum division of Reynolds Metals Company. Despite its much lower aluminum content, our Arkansas bauxite competes successfully with the richer ores from South America, mainly because the Arkansas bauxite need not be transported by sea.

Unlike most metals, aluminum cannot be reduced directly from its ore, the bauxite. First, the impurities in the ore must be separated from the aluminum hydroxide; this is a chemical

Casting aluminum

process. Next, the aluminum hydroxide must be calcined to produce pure aluminum oxide, or alumina. Last, the alumina must be reduced to metallic aluminum. The entire process is rather complex, and quite expensive, requiring large investments in plant and machinery, and consuming prodigious quantities of electric power.

The first step in the processing of bauxite into aluminum takes place at the mines. The raw ore taken out of the ground is hauled to a nearby mill where it is crushed, screened, and washed. The lumps of ore, now less than two inches in the greatest dimension, are carried into classifiers, where the washing process is repeated several times to remove as much clay as possible. Clay contains silicon oxide, or silica, an undesirable impurity in the processing of aluminum. After the washing process has been completed, the ore is thoroughly drained, dried in long rotating kilns, and is then ready for shipment to the alumina reducing plants.

There are now only three alumina plants in the United States: those of the Aluminum Company of America, in Illinois and Alabama, and the new plant of Reynolds Metals Company in Alabama, completed late in 1941.

Several processes of reducing bauxite to alumina are known; the one commonly used in this country is the Bayer process, developed about 50 years ago by Karl Josef Bayer, a German chemist. The crushed, washed, and dried bauxite from the mines is further crushed, and finally ground to powder. The powdered bauxite is then mixed with a hot caustic soda solution, and the mixture of soda and bauxite pumped into large pressure tanks, called "digesters." The caustic soda dissolves aluminum hydroxide out of the bauxite, and the liquid becomes a solution of sodium aluminate. The impurities in the ore do not dissolve, and are removed from the solution by filtering.

THE filtered sodium aluminate solution is then fed into huge precipitation tanks, where it is cooled. As the solution cools, aluminum hydroxide settles out of the solution in the form of white crystals. The caustic soda solution is then pumped off, to be used again, and the white crystals of aluminum hydroxide are dried, and then calcined in special kilns. The calcining process removes the water chemically combined with the crystals, leaving a white powdery mass of aluminum oxide. This white powdery mass is called *alumina*. For each pound of alumina, two pounds of high-grade bauxite were required.

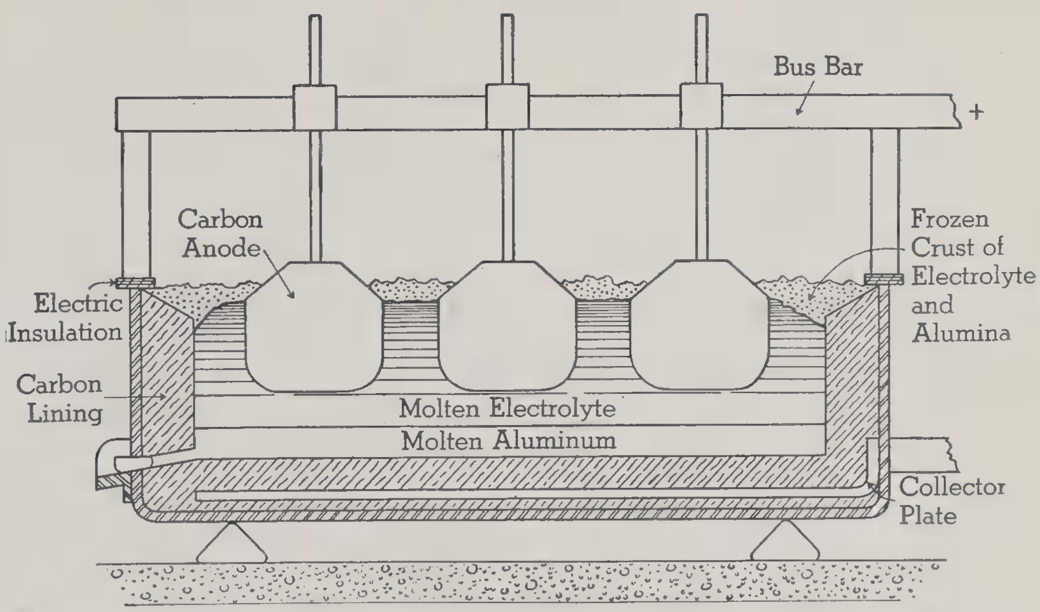
The next step is the reduction of alumina to aluminum. The process universally used is the Hall-Héroult electrolytic process, named after the American, Charles Martin Hall, and the Frenchman, Paul Louis Toussaint Héroult, who developed this process, independently of each other, in the last century. Because of the tremendous electric power requirements of the process, the aluminum reduction works are usually located near large hydroelectric plants where electricity is invariably both cheap and plentiful.

There are at present only five aluminum reduction plants in the United States—all of them belonging to Aluminum Company of America—distributed through New York, North Carolina, Tennessee, and Washington. A sixth plant, owned by Reynolds Metals Company, is nearing completion in Alabama, a seventh will be located in Washington.

The principal equipment of the aluminum reduction works is the electrolytic furnace, or cell. Each cell is a rectangular steel "bathtub," its walls lined with carbon which serves as the cathode or negative pole of the cell. The cell is filled with a rare white mineral, cryolite, or "ice stone," which is fused by the electric current into a molten mass. This molten cryolite is the electrolyte of the cell. Immersed in the cryolite bath are several carbon anodes, suspended from overhead busbars; these serve as the positive pole of the cell.

MOLTEN cryolite is the magic substance which dissolves alumina (aluminum oxide). The electric current passing through the molten cryolite bath decomposes the dissolved aluminum oxide into its component parts: aluminum and oxygen. The oxygen is liberated at the anodes and escapes through the crust at the top of the bath. Aluminum is deposited on the bottom and the walls of the cells (the cathode), and forms a molten layer of metal at the bottom of the bath, whence it can be drained off into ladles and cast into pigs.

The normal capacity of each cell is 250 pounds of aluminum, sufficient to cast five 50-pound pigs. Into the making of each pound of aluminum go four pounds of bauxite, three-quarters of a pound of carbon electrode, and 12



Illustrations courtesy Aluminum Company of America

Schematic diagram of an aluminum producing electrolytic cell

kilowatt-hours of electric energy.

The aluminum reduction process is a continuous operation. As the molten aluminum is drained off, more alumina is added to the cryolite bath. The cryolite itself is not affected by the process, and is used over and over again.

It is fortunate that cryolite is not affected by the process: the only commercial cryolite mine in the world is at Ivigtut, in Greenland. Greenland, you will recall, is now occupied by American troops. It is probable that more cryolite may be found in Iceland. We have troops in Iceland. But there is no connection between United States troops and cryolite. We have all the cryolite that we are likely to need; we could also make synthetic cryolite, fully as good as the real thing.

The pig aluminum still has to undergo several transformations before it becomes a battle-plane. The first step is to melt pig aluminum into ingots; this removes residual impurities and gives the bulk aluminum a more easily workable shape.

Sometimes an aluminum alloy and not pure aluminum is required; then the alloying is done at this stage. One of the best known and most frequently used alloys is duralumin. This remarkable alloy, after heat treatment, is as strong as mild steel, but weighs only one third as much. Duralumin is the alloy principally used in aircraft construction.

To become technical for a moment, aluminum has a specific gravity of 2.70: one fourth to one third of other common commercial metals. The metal is non-toxic, is resistant to corrosion, and has high thermal and electrical conductivities. What is more important, aluminum is a most versatile metal; it may be cast, rolled into bar and rod stock, drawn into wire, or rolled into plate, sheet, or foil. It may be drawn into tubing, or into extrusion shapes; it may be forged or pressed, or made into screw-machine products, rivets, or nails, or made into powder. There is no other metal which can serve industry in as many shapes and forms as can aluminum and its alloys.

Now, just where is the choke-point in our aluminum production?

There is no shortage of bauxite. We have, here and in South America, more than enough bauxite to make all the aluminum that we are going to need.

Is there a shortage of labor? Emphatically "No"! No skilled labor is required for the mining of bauxite. The processing of bauxite into aluminum is, essentially, an automatic operation, requiring very little labor.

There is no patent monopoly. All the important patents on the processing of aluminum expired long ago. Nor is there a monopoly in our aluminum industry; at least, the courts say so. In addition to Aluminum Company of America, the metal is being processed by Reynolds Metals Company, and Bohn Aluminum Company is expected to be soon added to the roster.

Admittedly, our aluminum plant facilities are still too few: there are as yet only three alumina plants, and only five aluminum reduction plants. But the few million dollars necessary to build additional plants will never present an obstacle to increased aluminum production so urgently needed.

THE real choke-point of aluminum production is electric power. Remember, 12 kilowatt-hours of electric energy are required to make one pound of aluminum. Last year, the aluminum industry needed, *each day*, enough electric energy to supply all needs of a modern city with a population of 25,000 persons for a whole year!

We do not have enough electric power. Already the towns and villages in the vicinity of aluminum reduction plants are feeling the pinch, will feel it more as time goes on. The great hydro-electric plants are all working at full capacity. Even the new Bonneville Dam project, barely completed, already has its entire output earmarked.

This choke-point is now being broken with the aid of our Government. Not so long ago Jesse H. Jones, Federal Loan Administrator, announced that the Defense Plant Corporation will provide $52,000,000 for the construction and operation of four aluminum plants by the Aluminum Company of America. With these additional plants American aluminum production should reach a much higher figure annually. Additional negotiations are now in progress with the Reynolds Metals Company and other aluminum producers.

The four new plants will be comprised of one alumina processing plant in Arkansas, and three aluminum reduction plants: one located in New York; another in a western state; and a third in Arkansas.

The ownership of the four new plants will remain with the Government. The Aluminum Company of America will merely operate them under a five-year lease, paying the Defense Plant Corporation 85 percent of net operational costs. The agreement provides that the new government plants must be operated at the same relative capacity as those now owned by the Aluminum Company of America.

With care and vigilance, we shall have enough aluminum—enough to win the War!

• • •

INSULATION

Board Made of Glass Replaces Cork

WITH importations of cork from Spain and Portugal becoming increasingly hazardous and uncertain, and with existing supplies in this country under rigid priorities, a new insulating board, said by experts to possess all of the insulating properties of cork, and to be superior in some qualifications, holds considerable interest. This new board, produced by Owens-Corning Fiberglas Corporation for low-temperature and roof-insulation applications, marks a development of unusual importance in that it will tend to release the United States from dependence upon cork in meeting the tremendous war-created demand for cold-storage refrigeration of perishable food supplies and industrial materials.

Known as AE Board, the new insulating material is made of pure glass fibers, compressed to a density of six pounds to the cubic foot, treated with a thermosetting binder, and completely enclosed in a sheath of asphalt that has a high melting point. Its heat conductivity is 0.265 B.T.U. per square foot per hour, per degree Fahrenheit, per inch thickness, at a mean temperature of 60 degrees, Fahrenheit. This compares with a figure of 0.27 for cork. Since the new insulating board is made of materials which are found in adequate quantities within the United States, a supply sufficient to meet all essential needs is assured.

It is estimated that the 1942 need for insulating materials for low-temperature installations will be in excess of 200,000,000 board feet. The feeding of the armed forces, the tremendous shifts in the industrial population, and the enormous expansion of industrial plants, all augment the normal requirements for cold-storage refrigeration. Adequate refrigeration is needed in the preparation, storage, and transportation of perishable foods and is an essential element in the processing of quick-frozen foods which today play an important role in the nation's diet. The cold processing of industrial materials, including many oils, chemicals, and rayon, requires the control of temperatures within a narrow range, necessitating adequate low-temperature insulation.

The value of roof insulation for in-

dustrial buildings has been firmly established. Insulation of the roof cuts fuel and air-conditioning costs. It also tends to prevent condensation on the underside of the deck, and consequent damage which may be caused by roof drip—an increasing problem in air-conditioned structures. Frequently the installation of adequate insulation in the roof makes it possible to reduce the size and cost of heating and air conditioning equipment. It is estimated that 300,000,000 square feet of roof insulation will be installed on new industrial buildings between now and the end of 1943.

The Fiberglas board is made in the "American Standard" size for refrigeration insulation—12 inches by 36 inches—and in thicknesses of one, one and a half, and two inches. The insulation has high resiliency, and shows almost complete recovery in five minutes after loading to 1728 pounds per square foot—a load far above the normal encountered in refrigerated spaces or roof-deck service.

All special-size pieces can be made up on the job by cutting the board to size, and sealing the cut edges with hot asphalt. The material can be sawed with an ordinary saw if the blade is frequently lubricated with kerosene to prevent the asphalt coating from gumming the teeth. For curved surfaces of large radii, the board can be slotted on one face and bent to fit the required curve.

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PLYWOOD—Soybean adhesives glue up to 2.3 billion square feet of plywood yearly—enough to make a four-foot "board-walk" around the equator four times, with several thousand feet of the strip left over.

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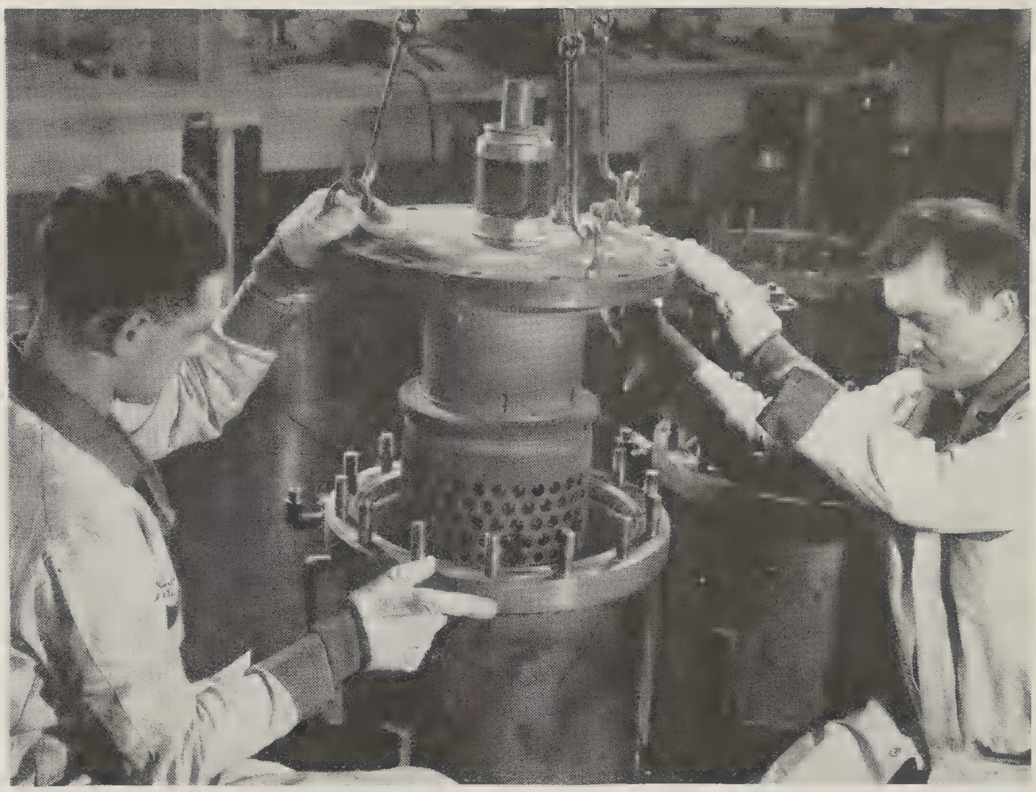
RESEARCH

Organization Plans For the Future

Announcement was recently made by the Auto-Ordnance Corporation, manufacturers of the Thompson Sub-Machine Gun, of the formation of a Department of Research and Development at Stamford, Connecticut, for the purpose of expediting America's war effort, continuing improvements in its own manufacturing, and the development of post-war products to cushion industrial readjustment following all-out military production.

This department includes Don D. Myers, well-known designing and research engineer of Toledo; Dr. H. H. Sheldon, formerly Professor of Physics at New York University and a contributor to Scientific American, and Mr. Albert Thomas, well-known inventor and designing engineer who was recently associated with the Glenn Martin Company.



Anode plate being lowered into the steel tank of an Ignitron, an electrical rectifier that is playing a large part in present-day magnesium production

MAGNESIUM

Production from the Sea Aided by New Device

A barrel-sized steel tank that sifts electrical charges through a pool of mercury is speeding production of two vital war metals by helping to "rescue" magnesium from the ocean and to extract aluminum from bauxite.

This "electrical alchemist"—known as the Ignitron—10 years ago was only a laboratory curiosity, but now is an important industrial tool for producing the lightweight metals urgently needed for military aircraft.

The Ignitron was developed by Dr. Joseph Slepian, associate director of the Westinghouse Research Laboratories, in co-operation with engineers L. R. Ludwig and J. H. Cox. The device expedites war production by changing alternating current electricity into the direct current required in electro-chemical processes used by magnesium and aluminum plants.

Half a million kilowatts of direct current electricity—enough power to drive 10,000 street cars—was added in 1941 to the power supply of aluminum plants in the United States and Canada by the installation of Ignitrons. Millions of pounds of magnesium are now being extracted from pumped sea water when magnesium hydrate is precipitated from the water, converted into magnesium chloride and reduced to magnesium by an electrolyzing process employing Ignitrons. About four and a half million tons of this important metal can be "rescued" from a cubic mile of sea water, according to statements by metallurgists.

Suspended in the Ignitron's tank is a graphite electrode connected to the alternating current supply. In the bottom of the tank is a shallow pool of mercury. Fastened above the pool is an inch-long pointed piece of boron carbide the thickness of a pencil. This dips into the mercury and is the spark plug or igniter that makes the Ignitron work.

In operation, positive electricity from the alternating current power line is conducted to the graphite electrode in the top of the Ignitron tank and also to the igniter. The instant this positive electricity reaches the igniter it forms a spark or "cathode spot" on the mercury pool and permits the power current to flow. When the current changes to the negative phase, the rectifying property of the mercury vapor prevents any discharge from passing in the reverse direction.

With 60-cycle current, this phenomenon is repeated 60 times a second, producing the required one-directional flow of current from the Ignitron to the industrial process for which such current is needed.

INDUSTRIAL TRENDS

NUTS, BEANS, SEEDS . . . AND OIL

Coconut palms, swaying gracefully in the warm, scented breezes of the South Pacific, are an important part of the imaged landscape of song and fiction writer; of far greater importance are they to a wide range of industries which, today, are in somewhat of a dither as to what to do about those products of the coconut which no longer reach our shores from far-off lands of fabled romance.

Outstanding product of the coconut palm is the oil yielded by the nuts, which, together with other vegetable oils from the Philippines and points west, enters such differing industries in the United States as those concerned with the production of foods, paints, leather, soap, lubricants, metals, and explosives.

Here is what the Department of Commerce has to say about the situation in oils and fats, the twins that are usually linked together and which include those of both vegetable and animal origin: "We normally produce domestically such food fats as we need and export, but domestic production is a third short of supplying all the fats and oils we need for soap, slightly more than a third short of those necessary industrially, and half short of our paint and varnish needs. Curtailment of our Far Eastern imports will directly affect the soap and glycerine, tin-plate, and textile industries, and will necessitate changes in composition among our manufactured fats and oils products."

Agriculture in the United States is being stepped up in certain branches to contribute its share in making up these shortages. For example, during 1942-43, production of peanut oil will be aimed at a goal 600 million pounds in excess of that produced during the 1941-42 season; for soybeans the figure will be 350 million pounds more, and for flaxseed some 100 million pounds. These increases will go a long way toward filling in the gaps left by coconut and other exotic oils in certain applications, but there is something about the coconut that makes its products particularly desirable. The oil gives quick-lathering properties to soap, in the manufacture of which it finds its widest use. The food industry consumes large quantities of coconut oil in the production of margarine, salad oils, shortenings, and so on. From it is obtained glycerine, essential to munitions manufacture, and this harks back to the soap industry in which glycerine is a major by-product that, today, is overshadowing in importance the main product.

But oil is not the only thing that the coconut yields; its shell, for example, is made into activated carbon which has the peculiar property of adsorbing gases and odors and finds application in the chemical industry as a decolorizing and clarifying agent. Greatest demand of the moment on activated carbon is, of course, in the manufacture of gas masks.

Before discussing the general trend that is rapidly developing as a result of the current shortage in coconuts, it is interesting to note a specific case where research has already licked the problem in one typical American way. In the leather industry coconut oil has long been used for certain types of tanning operations, in which its non-oxidizing qualities are particularly desirable. Faced with the need for finding a suitable substitute, one oil processing company has developed from domestic vegetable products an oil for use on leather that is said to be comparable in every way with coconut oil. So satisfactory is it, in fact, that interested parties have gone on record as saying that it is doubtful whether coconut oil will be able to re-establish itself in this particular industry after hostilities cease and supplies are once more available.

It cannot be recorded, however, that the problem of coconut oil can be solved so readily in every case. But there is a silver lining which, properly developed, can undoubtedly eliminate completely the dark cloud, or at least reduce it to unimportant dimensions. South America holds the answer. In that vast continent are a number of natural nuts which yield oils that are chemically equivalent to coconut oil. They are available in large quantities and, at least in some cases, have shells from which can be made activated carbon for the uses mentioned above.

There must be a joker somewhere. Otherwise, why would these sources of vegetable oils have remained undeveloped for so long, while the coconut held the center of the stage? There are several answers. All of those South American nuts which yield sufficient quantities of oil to warrant commercialization have hulls that are hard to crack. Crushing the hulls bruises or crushes the kernels, which contain the oil, thus spoiling the nut for further processing. There have been small quantities of oil from the babassu and cohune nuts placed on the market by South American companies, obtained through the long and tedious process of cracking the hard shells by hand and then pressing the oil from the kernels. But since hand cracking proceeds at a rate of about 180 nuts per hour, the oil output is exceedingly limited.

A further obstacle, but one that is not insurmountable, is the reluctance on the part of many South American countries to permit export of uncracked nuts of certain varieties. Reason, of course, is to keep the cracking industry at home for the benefit of native labor.

Yankee ingenuity has gone to work on mechanical crackers for these tough nuts, with a considerable degree of success. Several crackers have been devised that will crack the hulls at a high rate of speed, leaving the precious kernel intact. With these available, and with increasing co-operation between the United States and its southern neighbors, there is every reason to believe that South American nuts of a variety of species will soon aid greatly in replacing the coconut.

Here, then, is a definite trend in the vegetable oil industry which will be carefully watched by all other industries that have heretofore been dependent on oils imported from the Far East. And with one eye on the development of South American nut oils, the other eye will be kept on the field of synthetics at home. With such an opportunity opened by Mars, it is not hard to believe that the American chemist will soon pull from the bag a whole family of synthetics which will fit neatly into the industrial needs of the moment.

SYNTHETIC RUBBER . . . AND OIL

The petroleum industry which, directly or indirectly, supplies many of the sinews of peace and war, is going to play a much larger part in the synthetic-rubber picture than most people are aware of. Approximately three quarters of the production of this material at the end of 1941 was being made from petroleum-base raw materials. If the present trend continues, and it is indicated by government officials that it will, most, if not all, of the synthetic rubber being produced by 1943 will be made from products of the petroleum industry.

—The Editors

OUR *Point* OF VIEW

AN OPEN LETTER TO DONALD M. NELSON

Dear Mr. Nelson:

You are being widely quoted in the newspapers on the subject of dangerous complacency on the part of the American public in general and of American industry in particular. While I agree thoroughly with you that such complacency could, at the very least, prolong the length of the war and, at the worst, result in ultimate defeat of our nation, I feel that many of the charges of complacency are incorrectly aimed. Or, I might better say that some of them should be directed inward rather than outward.

My thoughts in this important phase of our all-out war effort are prompted by intimate contact with American industry. They are based on observation of progress and on conversations and correspondence with key men in a broad range of productive endeavor. Because I feel that these thoughts will be valuable to you in your work, I am taking this means of bringing them to your attention.

We—you and I and every other loyal American citizen—want to see this war prosecuted to a rapid and successful end. We all fully realize that the means lies in the hands of American industry. But such is the nature of present operations that American industry is not permitted, in many cases, to exercise its ability to produce tanks and planes, ships and guns with the same efficiency and speed that has characterized its work in the past in the fields of consumer goods and heavy materials for civilian use.

Why do I say "not permitted"? The reasons fall in several sectors, but, in my opinion, an outstanding one is in the limitations placed on production activities by the very men who should have the greatest interest in producing at the highest possible speed: Representatives of the Army and Navy charged with procurement and inspection.

Some cases in point will clarify the condition as I see it. While I cannot, of course, reveal the confidential sources from which these "case histories" are drawn, you may be sure that they are well authenticated.

First there is the case of a producer of machine-gun parts. The specifications to which machine-tool operators in this plant work call for tolerances so close that they can never be met in high-speed production. When they are met, by slow and tedious means, even the parts produced in that one shop are not interchangeable; assembly must be made by the cut-and-try method. Here is the direct antithesis of mass production methods, of the one system by which the production that we all want can be achieved. And the military inspectors of this work insist in one breath that the tolerances must be adhered to; in the next breath they call for production!

Then there is the case of a shipbuilding program where work was held up for a week because the government inspector on the job insisted that the welding electrodes being used were not the proper kind for the work. This insistance continued in spite of the fact that the workmen concerned were thoroughly familiar with welding procedure. It did not end until it was discovered that the inspector was using the wrong specification book! On this same job an inspector demanded that a certain part of the work be welded with 5/32-inch electrodes instead of the 1/4-inch rods that were being used, again despite the practical working knowledge of the workmen. In this case, as in many others, the manufacturer must bow to the orders of the government representatives in order to keep things moving at all.

In a third case, finishing operations on 37mm anti-tank gun mount are being carried out with 1/2-inch grinding wheels, just because the specifications call for such procedure. In the opinion of men who are qualified by experience to know, this lengthy operation serves no good purpose as far as the final performance of the gun is concerned, and might well be eliminated, with a definite speed-up of production.

I could go on with several more examples, but I am sure that those given will serve the present purpose.

From these case histories it is apparent that a great obstacle to full-speed production is hide-bound tradition in military circles. It appears that the men who are vested with the responsibility of supervising production in various industries are seldom selected for their knowledge of the particular work which they are to control.

This brings us to suggestions for a possible solution of some of the troubles that are inherent in any system in which production control requires specialized knowledge, if production is to be kept at the highest possible peak.

Army and Navy procurement officers and inspectors should be selected from the ranks of industrial technicians, rather than from the Services. Draw them from the automotive industry for supervision of automotive problems, from welding concerns for inspection of welding jobs, from ship-building yards for control of ship-building operations. If it is feared that technicians so selected might be biased in favor of their own organizations, set up a ruling that no man is to represent the government with the specific company from which he was drawn.

This procedure would probably not be looked upon with favor by Army and Navy officials because these men would not be instilled with the proper military spirit, would not hold to the traditions of the Services.

Let us assume that these are valid objections. Then give to these technicians who are to speed up production an intensive training course in the Army or Navy, thus providing such background as seems essential. This course, consuming perhaps two or three months, certainly would not hold up production any more than it is being held up at present by the sort of thing outlined in the case histories above. And when these men finish their training they would be qualified to couple the requirements of the Services with their expert knowledge of the requirements of mass production methods.

What I have proposed is merely an adaptation of the fundamentals upon which American industry has grown to world supremacy. When the right man is put in the right job, things hum; when the wrong man is invested with authority that no one can question, there is created a choke point that is all too frequently blamed on almost everything but the one out-of-place factor.

Very truly yours,
A. P. Peck

Patents and Free Enterprise

Anti-Trust Laws Can Control Abuse of Patents Without the Necessity of Destroying Patent Rights

WILLIAM R. BALLARD
General Patent Attorney,
American Telephone and Telegraph Company

THE American patent system seems to do well the thing it was intended to do, namely, "to promote the progress of science and the useful arts." We are the most inventive and progressive people in the world, and during the past century and a half over two and a quarter million patents have been issued to inventors. Right now, however, there is agitation in certain quarters to change our patent laws radically on the ground that they are in collision with the anti-trust laws, that they take something from the public merely to benefit an individual, and that they are being misused by patentees. The reasons back of this agitation are wholly unsound, but there is real danger that they may prevail and kill the goose that lays the golden eggs.

A patent is not a private privilege carved out of the public domain. So far from being a means of taking something from the public and giving it to an individual, a patent is a means for getting something from an individual and giving it to the public. If a man makes an invention of the kind which can be protected by a patent, it is something which the public does not then have, and to which it has no claim. That invention belongs to the man who made it. He may, if he choose, keep it secret and practice it to his own profit. He may, if he choose, let the art die with him. If anyone surreptitiously filches his secret invention, he has his remedy at law for the injury. The patent system is designed to induce him not only to do the inventing but to disclose his invention and give it to the public gratis after the term of the patent, in return for the assurance that he will be protected in the exclusive use of his own for those seventeen years, notwithstanding the disclosure. In this transaction, it is clear that only the inventor gives up anything of substance. To purchase the residuary rights in his invention the public contributes neither money nor anything else it possesses. It gives only a promise of temporary protection for the inventor's own intellectual property so that he may, if he can, make a profit for himself during the period of protection.

As long ago as 1852 Daniel Webster stated it as plainly as this:

". . . The Constitution does not attempt to *give* an inventor a right to his invention, or to an author a right to his literary productions. No such thing. But the Constitution *recognizes* an original, pre-existing, inherent right of property in the invention, and authorizes Congress to secure to inventors the enjoyment of that right. But the right existed before the Constitution and above the Constitution, and is, as a natural right, more clear than that which a man can assert in almost any other kind of property. What a man earns by thought, study, and care, is as much his own, as what he obtains by his hands. It is said that, by the natural law, the son has no right to inherit the estate of his father—or to take it by devise. But the natural law gives a man a right to his own acquisitions, as in the case of securing a quadruped, a bird, or a fish by his skill, industry, or perseverance. Invention, as a right of property, stands higher than inheritance or devise, because *it is personal earning*. It is more like acquisitions by the original right of nature. In all these there is an effort of mind as well as muscular strength.

"Upon acknowledged principles, rights acquired by invention stand on plainer principles of natural law than most other rights of property. Blackstone, and every other able writer on public law, thus regards this natural right and asserts man's title to his own invention of earnings.

"The right of an inventor to his invention is no monopoly. It is no monopoly in any other sense than as a man's own house is a monopoly. A monopoly, as it was understood in the ancient law, was a grant of the right to buy, sell, or carry on some particular trade, conferred on one of the king's subjects to the exclusion of all the rest. Such a monopoly is unjust. But a man's right to his own invention is a very different matter. It is no more a monopoly for him to possess that, than to possess his own homestead.

"But there is one remarkable difference in the two cases, which is this, that property in a man's own invention presents the only case where he is made to pay for the exclusive enjoyment of his own. For by law the permission so to enjoy the invention for a certain number of years is granted, on the condition that, at the expiration of the patent, the invention shall belong to the public. Not so with houses; not so with lands; nothing is paid for them, except the usual amount of taxation; but for the right to use his own, which the natural law gives him, the inventor, as we have just seen, pays an enormous price. Yet there is a clamor out-of-doors, calculated to debauch the public mind." (Emphasis by Mr. Webster.)

■ Even in times of economic uncertainty, the patent remains the cornerstone of business and industry, large and small. In view of current attempts to undermine our patent system by attacking it as a system which fosters "trusts" and makes it possible for an inventor to establish a "monopoly," the present article is unusually timely. By emphasizing that the inventor gives something to the public, rather than taking from it a right which the public should possess, the author stresses that phase of our patent law which is fundamental, yet all too often overlooked.—*The Editor* ■

Chief Justice Marshal said of the patent: "It is the reward stipulated for the advantages derived by the public for the exertions of the individual, and is intended as a stimulus to those exertions . . . The public yields nothing which it has not agreed to yield; it receives all which it has contracted to receive. The full benefit of the discovery, after its enjoyment by the discoverer for 14 (now 17) years, is preserved; and for his exclusive enjoyment of it during that time the public faith is pledged."

IT is sometimes said that patentees have a practice of prolonging the life of their patents beyond the 17-year period. This is done, we are told, by taking out improvement patents.

The simple fact, of course, is that no patentee can prolong the life of his patent by so much as a single day.

When a patent has run its 17 years, it ceases at once to be a bar to anyone in any way. The making, using, or selling of the thing covered by the patent is as free to one man as to another; and this is true whether improvement patents have been taken out or not.

And during the life of the patent one man as much as another is free to make and to patent improvements on the preceding invention. Of course, the man who makes the best improvement will, after the first patent expires, be in a better position to compete (so far as patents are concerned) than the man who makes a poor improvement, or none. If the same man who conducted a business under the first patent makes the best improvements he, of course, will have this competitive advantage; but this is the result of his effort and ability in making the improvements—not in any sense because of an extension of the monopoly of his old patent.

In this matter of making and patenting improvements there is a field of perfectly free competition. If the outsider, who wants to get in, has the ability and is willing to spend the time, money, and effort required to make and to patent the best improvements, he will hold the advantage in the business over the original patent owner when that patent expires. If he has not the ability or is not willing to make the effort, there is no reason why he should be permitted to take, free of cost, the improvements of someone else who has spent time, money, and effort in perfecting them.

We sometimes hear it said that the *assignment* of a patent—especially an assignment to a corporation—diverts it from its intended purpose and turns it to an unforeseen and undesirable end such as "the pursuit of gain." There is no truth in this.

It seems almost too obvious to require stating that the very purpose of the patent law in granting an inventor a patent is to enable him to reap a profit on the invention. The chance to do that is his reward for contributing to the advancement of science and the useful arts by making and disclosing the invention. From the point of view of the public, it is of no importance at all whether the patentee makes the profit by manufacturing and selling the invention himself, or makes it by selling his exclusive right to someone else. If he sells his patent to someone else, the purchaser, whether a corporation or an individual, gets no rights which the original patentee did not have.

Obviously either the inventor *or* his assignee may use the patent unlawfully, just as he may use any other private property unlawfully. For example, he may make an agreement or combination in restraint of trade which involves his patent, just as such an agreement may involve his grain or his horses. But the cure for this is not to decry the sale of the patent or the grain or the horses, but to prosecute the perpetrator of the agreement (whether inventor or assignee) under the anti-trust laws if he transgresses those laws.

Some seem to assume that a patentee, as distinct from the owner of other property, is under some special obligation to society. Having read Article 1, Section 8, of the Constitution and found that the granting of the patent is intended "to promote the progress of science and useful arts," they jump to the conclusion that it is the patentee upon whom falls the duty of promoting the progress of science and the useful arts. Of course, this is plain foolishness. The Constitution expressly states that it is Congress that is to promote the progress of science and the useful arts. And the precise way Congress is to promote them is stated, namely: "by securing for limited times to . . . inventors the exclusive right to their . . . discoveries." So, it is the fact that the exclusive rights are granted which promotes the progress of science and the useful arts, and not something the patentee is expected to do after the grant is made. Once made, the grant, like any other piece of property, is something belonging entirely to the grantee. It is intended for his benefit and with it he may, as with his horse or his grain, do just as he pleases. The patentee's obligation to society is no greater, and of course no less, than the obligation of the holder of any other piece of personal property. The patent is merely property he has bought by yielding the price specified by the Government.

Of course, anyone so blind as to believe that human beings have already attained such perfection that we can now thrive and progress without the stimulus of any private ownership at all will object to the private ownership of the patent right, and, since it seems easier to vilify this right as a "monopoly" than it is the corresponding monopoly in one's horse or his grain, it is natural that such a person should pick on patent property for propaganda purposes.

Quite obviously, the right of any person in any private property does, to some extent, limit the freedom of others in conducting their business enterprises (and in other ways). If A owns a farm, B, of course, is not free to conduct an agricultural enterprise that would involve planting and cultivating A's acres. Just so, if A owns a patent on an invention, B is not free to conduct a manufacturing enterprise which would involve the making and selling of A's invention. And most certainly in neither case is there any reason why B should be "free" to do such a thing.

The American idea of free enterprise is not that a man should be free without permission to do business with the property of others, but that so long as he respects the property and other rights of his fellow men he shall be free to conduct whatever enterprise he will, wherever he will, and for such time and in such way as he may choose —and especially that he shall be free, so far as possible, from interference by the Government.

The basic relation between patents and free enterprise is so simple that it can be stated in one paragraph. It is precisely the same relation as between any other private property and free enterprise. While a man's, or a company's, ownership of private property is always in a true sense a monopoly of that property, and the control of it is often referred to as absolute, nevertheless it is also always true that the use of such property, whether it be patents, or grain, or horses, is subject to the general laws governing the use of property, as, for example, the anti-trust laws. And while, as already noted, private ownership of property is necessarily a limitation on the activities of others, it is also true that private ownership and a complete control of the property involved not only promote free enterprise but are almost essential to it. No one can have a really free enterprise based upon a farm or a grocery store unless he has complete control of the farm or the store, and the same is true as to patents. The ownership of patents and the complete control they give of the invention covered are the cornerstones of hundreds of small enterprises in this country.

To propose the destruction of useful property merely because it might be used as the subject of an agreement in restraint of trade, or otherwise in contravention of law, is childish. That, in substance, is what some now propose as to patents. History indicates that oil is more likely to be used as the basis of combinations in restraint of trade than are alphabet blocks or tigers, but that is no reason for destroying or for denaturing the oil; and anyone who suggested that as the remedy would risk a trip to a clinic for mental observation.

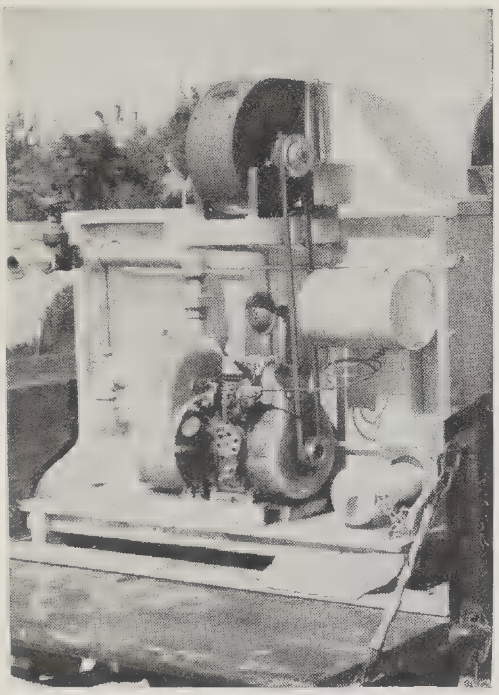
Experience shows that patents, like oil, contribute to the public welfare. Let them remain as they are and continue their good work of promoting science and the useful arts. If owners of patents use them as the basis of agreements or combinations to get control of things which the patents themselves do not cover, the remedy is not to destroy the patent right but to enforce the anti-trust laws.

Air-Conditioning Fish

Mechanical Means Used to Provide Oxygen, Keep Temperature Low When Transporting Hatchery Fish

F. WALLACE TABER

ARTIFICIAL rearing of fish fry has long been a constant headache to all concerned—not excluding the fish. Nevertheless, every state in the Union now rears fish fry for restocking depleted streams and lakes, some states boasting several million fry production annually; others only a few thousand. Nevada is in the latter category, but were she granted a handicap because of the many problems with which she must cope, she would undoubtedly be in the first rank.



Blower and motor

Fish require oxygen to live; lack of oxygen results in suffocation. Fish do not, however, utilize the O part of H_2O; they are not capable of breaking down the compound. The oxygen which fish breathe is that which has been dissolved in the water. The dissolved oxygen is extracted by means of the haemoglobin of the fish's blood, which comes into very close contact with the water as a result of the extremely thin gill membranes through which the blood freely circulates. Therefore, not all water is capable of sustaining fish life: fish must have oxygen dissolved in water to live.

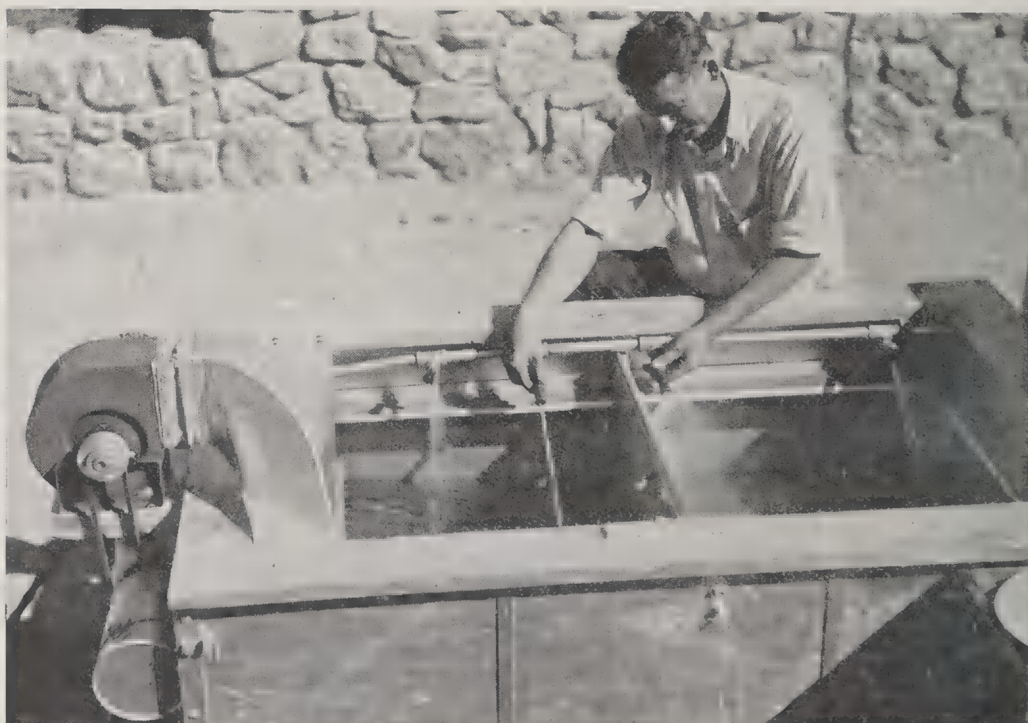
It is likewise a well-known principle of physics that colder water has a greater capacity for dissolved oxygen than has warm water. The lower the temperature, the greater the potential oxygen carrying capacity; conversely, the warmer the water, the smaller the dissolved oxygen carrying capacity. Therefore, it is desirable in transferring fish aboard a truck not only to keep the water constantly aerated, but also to maintain a low temperature so that the water will take on the oxygen as it is passed through the liquid.

In most states, when fish are transferred from hatchery to wild streams and lakes, an ordinary air pump supplies the necessary aeration and a cake of ice maintains the desirable low temperature. Not so in Nevada! There the sweltering desert temperatures hover around 118 degrees in the shade for days on end, and a cake of ice lasts about as long as the well-known snowball. Nevertheless, Nevada fisheries experts last year carried more than 120,000 baby fish well over 2000 miles with losses so small as to be negligible.

Machinery made possible this success. Mounted on the back of a truck, a pump driven by a one horsepower engine circulates water through the fish tank. In operation, water is drawn from the bottom of the tank and discharged with considerable force from small spray jets spaced along a common delivery line. The tank is completely covered with a tight-fitting lid into which is cut a slot-like opening in the rear part of the cover. A funnel-like ventilator situated forward on the cab collects air when the truck is in motion, passes it through the spray of water, to be finally exhausted through the opening in the rear of the cover. Not only does the continual breeze adequately aerate the falling water but at the same time the evaporation thus brought about is sufficient to keep the water several degrees below the atmospheric temperature. On one trip of a hundred miles with the air temperature oscillating between 112 and 114 degrees, Fahrenheit, spring water with an original temperature of 77 degrees gained but a single degree over the entire trip. A tank of water similarly treated, but minus the ventilator, jumped from 77 degrees to nearly 90 during the first hour of running. Needless to say, the bass fry in this check tank were all dead long before the destination was reached.

A SECOND method of aeration is now being tried because of the difficulties encountered when the truck has to stand idle with the fish on board. In such a condition there would naturally be no air circulation. In these experiments a blower of the squirrel-cage type is mounted above the motor and connected by a belt to the motor shaft. The blower is in turn connected to an air duct that leads the air into the spray chamber above the water.

This mechanical method of forcing



Photos by National Park Service

Blower supplies air; pump produces water spray

the air through the spray has the advantage of cooling the tank water while the truck is at rest as well as when the truck is traveling along the highway. It also produces a uniform air flow throughout the spray chamber at all times, while the flow of air introduced by the funnel mounted on the cab varies with the velocity and direction of the wind and the speed of the truck.

Ralph H. Olson, inventor of this cooling system, tested the apparatus during last July and August, the hottest season on the desert. Some 15,000 miles were chalked up under the most adverse desert conditions, with temperatures often ranging up to 120 degrees in the shade. During this time 300,000 bass and blue-gill fry were carried through in fine shape. "The fish arrived at their destinations just as lively, if not more so, than when they left the hatchery," Mr. Olsen said. "Some of the trips were as far as 600 miles one way, yet I have never used a single pound of ice even though the trips are often made during the heat of the day."

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OZONE

Still Much to be Learned About its Effects

Chemists are reaching a better understanding of the toxic effect of ozone on humans, concerning which there has been a surprising lack of agreement among investigators, according to Clark E. Thorp of Chicago, industrial chemist, in a report to the Americal Chemical Society.

Ozone, a faintly blue form of oxygen which is present in minute amounts in the atmosphere and is encountered in many phases of modern electrified industry, is formed in practical quantities by spark discharges and by ultra-violet rays. Spark discharges also form nitrogen oxides from air. Tests reported by Mr. Thorp show a large difference of toxicity between pure ozone and ozone containing nitrogen oxides.

"Ozone free of oxides of nitrogen is non-toxic in concentrations below 20 parts per million." Mr. Thorp says. "Ozone containing 47 percent nitrogen oxides has bactericidal properties.

"Ozone plus nitrogen oxides may be more toxic than nitrogen oxides alone and should be investigated further. The variance of opinion to ozone toxicity is probably due to results obtained with ozone containing varying amounts of nitrogen oxides."

Two hundredths of one part of pure ozone per million can be detected only by chemical analysis, but five-hundredths of a part per million is detectable by a keen sense of smell. One tenth of a part per million of pure ozone results in an easily detectable, but not unpleasant, cloverlike odor.

At one part per million, the odor still is not unpleasant, although continued exposure became annoying to 25 percent of those tested. Exposure of seven hours a day for five days did not cause irritation of nose and throat.

Three parts per million of pure ozone has no killing power on coli (bacteria) in water, or on bread mold spores in air; nor has ten parts per million any effect on mice after six hours' exposure. Fifteen parts per million bubbled through a representative sample of algae, tiny tree plants growing in water, for one hour had no noticeable effect; after six days the algae had tripled in growth.

Four hours' exposure to air containing 20 parts per million of pure ozone did not affect mice, nor produce soreness of nose or throat in humans. But 30 parts per million caused coma in mice after five hours' exposure, though coli were not killed. The mice revived when subjected to normal air. Five hours' exposure to 50 parts per million killed mice, but this proportion used in six hours' aeration of flour did not kill any weevils or affect larvae.

One hundred parts per million of pure ozone were lethal to mice in one hour, and a one-minute exposure of humans resulted in dried skin, severe sore throat. One hundred parts per million also killed 20 percent of the coli in water containing 500 coli per cubic centimeter with one hour of aeration per liter.

The effect of impure ozone, containing 47 percent oxides of nitrogen and 53 percent ozone, was quite different. According to parts per million, the following observations were reported: one-hundredth of a part per million—threshold for keen smell; two-hundredths—easily detectable to people; five-hundredths—odor objectionable to some people; one-tenth—acid odor highly objectionable, causing sharpness in throat.

One part per million, the limit at which a test was made on humans—produced headache after two hours and sore throat after three hours; three p.p.m.—kills all coli in water when coli number less than 220 to the cubic centimeter, five hours' aeration per liter; five p.p.m.—kills all coli in water when coli less than 1,000 per cubic centimeter, five hours' aeration per liter.

Ten p.p.m.—lethal to mice in five hours' exposure; 15 p.p.m.—kills algae after ten minutes' bubbling through water, and algae did not grow again in the water; 30 p.p.m.—kills all coli in water when coli less than 1,000 per cubic centimeter, five minutes' aeration per liter; 50 p.p.m.—kills flour weevils and 80 percent of larvae after 30 minutes' aeration through flour, turns flour light brown in color.

"The toxic limit for nitrogen oxides has been determined to be 2.3 parts per million by weight," Mr. Thorp says. "The toxic limit for ozone containing 47 percent nitrogen oxides is shown in this report to be only 1 part per million, which would be the equivalent of about 0.5 part per million for the oxides of nitrogen. The presence of ozone evidently increases the toxicity of nitrogen oxides to a considerable degree. Although it would require a comprehensive physiological test on humans, this action should be investigated further by some one equipped to carry out such research."

Each molecule of pure ozone has three atoms of oxygen. Used commercially for sterilizing water, purifying air, and bleaching, ozone is one and a half times denser than ordinary oxygen gas. It is created every time a silent electric discharge goes through a current of oxygen or air.

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GASOLINE—Motor fuel for highway use, reported in these pages in our February issue as totaling 22,000,000 gallons in 1940, should have been placed at 22,000,000,000 gallons.

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SPORTS EQUIPMENT

Must be Conserved "For the Duration"

At the recent National Sportsmen's Show in New York (also at numerous others held throughout the country) exhibitors generally cautioned sportsmen to treat their equipment kindly and thereby help win the war. Before long the shortage of metal, rubber, cork, and other materials will be very evident. One material which must be conserved is wool, for it is used not only for clothing, but to a very large extent in felt, and felt is utilized to a greater degree in sports goods than the average person realizes. Its application ranges from boot and moccasin linings to shoulder pads for hunters and heavy fishing tackle harness, archery arm guards and targets, camping equipment. In motor boats and airplanes it is employed to absorb vibration; it is used for canoe and boat seat cushions, helmets for participants in speed events on land, air, and sea, and so on. It finds its way into skiing outfits and

many other sports costumes and accessories, golf club grips, and hundreds of other items.

Variable cushioning properties make felt an ideal shock absorber. For example, in a baseball catcher's mitt felt with non-resilient qualities must be used; otherwise the ball would bounce out of the palm. And yet, for various other purposes, high resiliency is called for, as in helmets, tumbling mats, basketball knee-pads and so forth. Thick felt insoles are unsurpassed in cases where boots are too large, especially when long hikes are in prospect. These insoles can be cut with scissors to give maximum foot comfort.

OIL TRANSPORT

On the Mississippi Will Reach 200 Million Barrels in 1942

Nearly 200,000,000 barrels of crude oil and petroleum products will be moved on the more than 5000 miles of the Mississippi Waterways System to inland refineries and markets in 1942, helping to relieve the railroads now when they are so burdened, and when tank cars are needed in unprecedented numbers for West Coast and East Coast services to replace tank ships.

The increase in the movement of petroleum on the inland waterways has been phenomenal, according to authoritative reports. The estimated 1942 total will be more than four times the less than 50,000,000 barrels moved in 1933. Not only has transportation on the main waterways increased spectacularly, but new oil ports, such as Minneapolis-St. Paul, have been opened up within the past two or three years. Prior to 1939, scarcely any petroleum moved into the Twin Cities by water.

Petroleum moves in barges out of all the great oil ports on the Gulf of Mexico, from Corpus Christi to New Orleans, up the Mississippi to the Missouri, the Illinois, the Tennessee, the Cumberland, the Ohio, the Allegheny, the Monongahela, and the other navigable rivers in the system. On the Ohio and Monongahela, barge-borne petroleum is transported from the southwest to ports 100 miles above Pittsburgh. On the Kanawha, petroleum reaches Charleston, West Virginia. Using the Illinois River and canal, shipments from the Gulf of Mexico can enter the Great Lakes waterways system. Up the Missouri petroleum moves to new terminals in Iowa and Nebraska.

The number of river-side oil terminals on the Mississippi system has grown tremendously. At the end of 1941 there were listed 252 terminals at 135 points in 17 states. Two years before, in 1939, only 160 oil terminals were reported. The terminals are of all sizes, some of the most modern providing storage and terminal facilities for more than 5,000,000 gallons of petroleum products.

Nearly one fourth of the country's entire refining capacity is concentrated along the Texas and Louisiana Gulf Coasts, from which the inland barge movement gets most of its supplies.

TUBING

For Electrical Insulation is Strong, Flexible

A new tubing with excellent resistance to brittleness down to —50 degrees, Centigrade, has been developed by the Irvington Varnish & Insulator Company. This transparent tubing, known as Transflex, was made especially to secure continued, effective insulation on aircraft flying at high altitudes; it has already been utilized by such companies as Douglas Aircraft and Curtiss-Wright. However, its toughness and rubber-like qualities make it useful for a variety of other industrial and electrical applications. For example, the transparency of Transflex permits quick location of wire breaks and ready identification of wires which have been snaked through it.

Can be tied in knots

Transflex is a Fibronized tubing available from size No. 14 to $\frac{5}{8}$ of an inch inside diameter; it is extremely flexible, as shown by the accompanying photograph. Its tensile strength is 3000 pounds per square inch. Its dielectric strength (conducted on a tubing with a wall thickness of approximately .020 of an inch) is 850 VPM when dry and 815 VPM when wet. Water absorption is 0.4 percent in weight after 24 hours immersion.

USEFUL PLANT

Bamboo Can Supply All Human Needs

What is the most universally-used plant that grows? Is it, as many have stoutly maintained, the coconut palm? Or sorghum, maize, sugar cane, or peanut? No, not one of these, according to Dr. Willard M. Porterfield, Jr., of the United States Soil Conservation Servive. It is bamboo.

There is not a category of human needs which cannot be supplied by some form of product of bamboo, declares Dr. Porterfield. Food, weapons, shelter, implements, clothes, furniture, baskets and containers, bridges, conduction pipes, paper, cable, ornaments, and many very specialized articles are made from it.

The Forest Research Institute of Dehra Dun in India believes that the final solution of the world's recurring shortage of raw material for paper will only be found in the forest and waste lands of the tropical and sub-tropical belts, with bamboo the most important product.

Bamboo has figured largely in the past history of Asiatic and many tropical peoples and has been the subject of artistic rendering in all the arts. The famous Bamboo Books, containing more than 100,000 seal characters, comprising 15 different works dealing with the history of China for 2200 years, were written on tablets made of bamboo which were strung together like a fan.

To bring the uses of bamboo up to date, a bamboo basket has been designed and used by the Chinese to protect their most important buildings from Japanese air raiders. According to W. R. Peck, Counsellor of the United States Embassy, Chungking, China, the Chinese construct a three-story bamboo framework atop buildings and load all three floors with cut bamboo. When a bomb hits, it is harmlessly detonated before it reaches the building itself.—*Science Service.*

ROAD-RAIL

Vehicle for Use in Explosives Plants

A speedy motorized vehicle which rolls on rubber tires on the highway or on a railroad track, is being used

At home on road or rail

to eliminate some of the hazards in the movement of explosives at arsenals and powder depots. Called the "Auto-Railer," the vehicle employs special rubber tires, developed by The B. F. Goodrich Company, which work in conjunction with conventional flanged guide wheels for operation on railroad tracks. Designed and manufactured by the Evans Products Company, the Auto-Railer has a top speed forward or reverse of 60 miles an hour, either on highway or rail, and, thanks to the windshield-wiper action of the non-skid treads, it can be stopped as quickly on the rails as can a modern automobile on the road.

The transition from highway to rail takes but a few seconds. The rail assembly is operated by a hydraulic jack, controlled from the driver's seat, which lowers or raises the flanged steel guide wheels. On the rails, the rubber tires bear a portion of the load normally carried entirely by the flanged rail wheels.

Weighing 8750 pounds, and capable of carrying 3000 pounds of explosives, the vehicle is completely spark-proofed, with exterior wiring throughout, while the cushioning properties of the rubber tires eliminate jolts and jars.

Several of the vehicles are already in use at one of the Ordnance Department's bomb and shell loading plants in Ohio, and more units are in manufacture for use in other arsenals.

PSYCHIC RESEARCH

● Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. Further reports of The Scientific American Committee for the Investigation of Psychic Phenomena will be published in forthcoming issues. ●

REPAIR KIT

For Nicked and Scratched Furniture

With the proper materials available, enterprising householders can, with but little practice, restore marred furniture surfaces to the appearance of the original condition by removing scratches, filling in nicks, dents, gouges, and so on.

A new furniture finish repair kit, just announced by the American Household Bureau, contains every essential material and piece of equipment necessary to turn out professional-looking repair jobs quickly.

This new kit contains an assortment of shellac sticks, bottles of light and dark stain, shading lacquer, alcohol lamp with fuel, spatula, scratch stick, liquid penetrating scratch polish, steel wool, felt rubbing pad, shellac rubbing liquid, sandpaper, and touch-up brushes. These materials and equipment make it possible to repair any finely finished furniture surface in a matter of a few minutes time.

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MAN MADE—Hardly a single component of an airplane or the fuel it burns or the oil which lubricates it or the liquid which cools its engine is a simple, natural product; even the metals of which it is in part constructed have been so changed by scientific research that metallurgists of 20 years ago would not have known them.

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WINCHES

Pull Army Cars Out of Trouble

Half-Tracs of the United States Army are designed to go where no other vehicles except tanks will go. This means that the reconnaissance

Hard to stop; hard to stick

units and personnel carriers will go through mud and water as well as across the roughest kind of terrain, not excluding trenches and shell holes. However, there is a type of ground which is closely akin to quick sand—a surface so fluid that any vehicle, even with tractor belt support, will sink. In order to take care of such conditions, the new Half-Tracs designated for quick-sand territory are being equipped with sturdy winches which drive from the transmission. These winches are used not only to help pull the vehicles out of difficult places, but for any other purpose requiring a winch.

The winch on Half-Tracs made by White Motor Company is mounted on the front so as to be more quickly available. In this handy location it is always ready for action. The vehicle can be headed in wherever direction the winch is needed and it is never necessary to unload the Half-Trac in order to use the winch, as would be necessary if it had a body location. With this equipment, the Half-Trac is ready for any eventuality and becomes a vehicle of even greater utility.

PIERCING FOG

Yellow Lenses Hold No Advantage

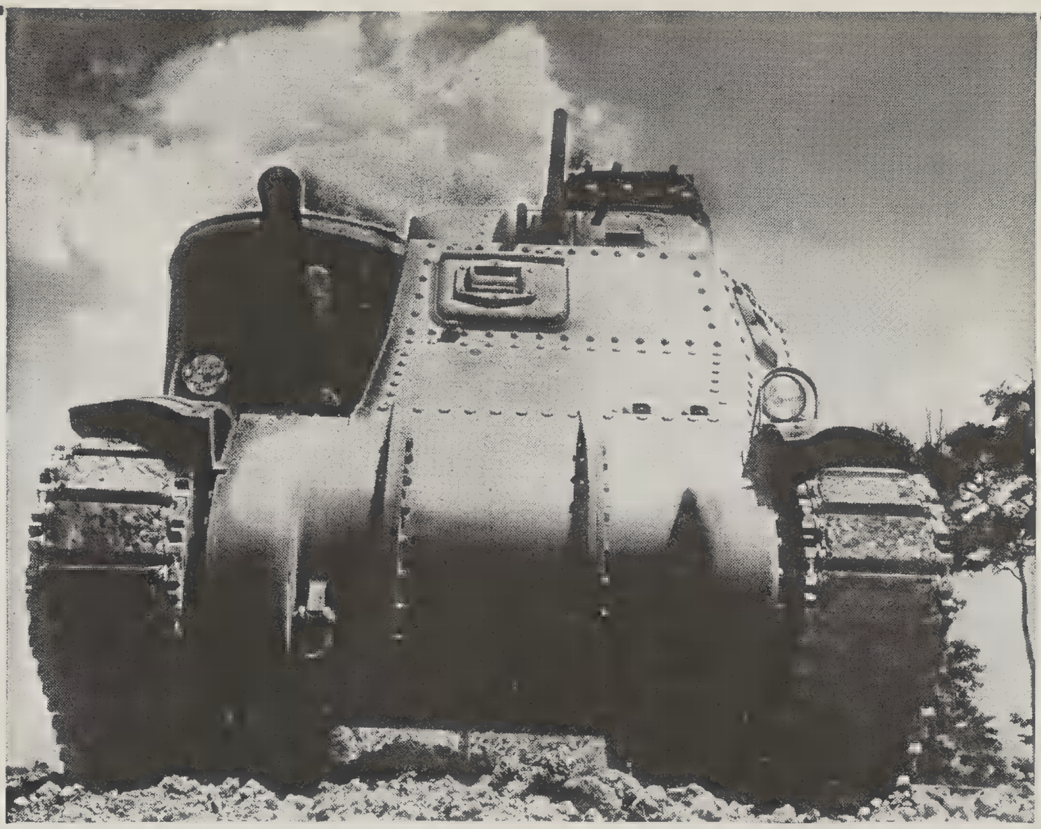
That yellow light is no better at piercing fog than the light of an ordinary tungsten lamp is shown by experiments recently carried out by Dr. Matthew Luckiesh, research physicist and Franklin medalist, and L. L. Holladay, of the Lighting Research Laboratory of the General Electric Company, Nela Park, Cleveland, and reported in the *Journal of the Optical Society of America.*

The so-called fog-lamps, consisting of yellow lenses which absorb from 20 to 35 percent of the tungsten-filament light, must contribute something to the seeing to offset the loss due to less light. No satisfactory tests have been published, but the present investigation makes it more than unlikely that they have any advantage. Similar fog-piercing claims have been made for the new sodium lamps. In this case there is no loss of light by colored filters, for the light is inherently yellow and practically monochromatic. Yet even this lamp showed no significant superiority over the tungsten lamp in fog-penetrating qualities.

The two lamps of equal intensity were tested side by side in clear weather, moderate fog, dense fog, mist, and snow. They were tested by day and by night. Also, a pair of lamps of low intensity and a pair of high intensity were used. Many experienced observers made many readings on a Luckiesh-Moss visibility meter at a distance of 1000 feet. No significant differences showed in the averages.

The report explains that the fog-penetrating power of a light does indeed depend on its color or wavelength, as has been generally known. Thus, blue light, which is of short wavelength, penetrates fog less than red light, which is of long wavelength. The sodium lamp emits yellow light that is practically of a single wavelength. This wavelength is about midway between those of the red and blue lights. Hence the fog-penetrating power of the sodium light is just about middling.

The white light of the tungsten fila-



ment contains all the colors from red to blue. It is true that the blue rays are cut down by the fog, but the remaining red rays have a fog-penetrating power superior to the yellow light of the sodium lamps. This evens the score.

METAL "WHALE"

Has Appetite of 25 Tons A Day

TWENTY-FIVE tons of steel is the daily dish of this whale-like machine in the metal conservation department of the Westinghouse Electric & Manufacturing Company. When parts of motors, generators, and other electrical machines are punched out of steel sheets, many odd-shaped pieces are left. Fed to the furnaces of steel mills, this scrap again becomes usable steel valuable to the nation's war effort. But because the scrap is worth $3 a ton more if cut into sizes that fit easily into the furnaces, it goes first to the "scraphouse whale"—a great shearing machine driven by a 50-horsepower motor. This mammoth shear bites off chunks of five-inch-thick metal as easily as scissors snip a piece of paper. Each month it helps salvage enough steel to build 30 medium Army tanks—one a day.

Five-inch-thick metal at a bite

DOUBLE CHECK

On Insecticide Reveals Unwanted Features

INSECTICIDE chemists of the U. S. Department of Agriculture have a continuing program of trying to find new and better insect poisons. What they seek are new chemicals that, on the one hand, are deadly to insects and, on the other, are not harmful to humans. They first synthesize new compounds which entomologists then test on insects. If results are promising, a stock of the material is sent to San Francisco where the Bureau of Agricultural Chemistry and Engineering and the Stanford University School of Medicine cooperate in maintaining a pharmacology laboratory to find out whether new poisons are safer than the poisons they would displace.

Entomologists are working particularly to find safer substitutes for the lead, arsenic, and fluorine poisons now in use.

Recent experience with the one new poison, reported by Bureau scientists Wilson, DeEds, and Cox in *Cancer Research*, illustrates how this protective research operates. A compound called "2-acetaminofluorene" tested well as an insect killer. At the Stanford laboratory heavy single doses were not harmful to rats and rabbits. The animals eliminated the poisons. So far, so good! But it turned out that with lighter doses in the food day after day, the growth of the animals was checked and they sickened and died within 100 days. Not so good!

To make the test even more thorough, the dose was reduced until it did not check growth—and the result was even less favorable. After continued feeding for from five months to a year it was discovered that even minute doses were causing cancer in many of the rats. When this report came back to Washington, the work with this new insecticide was dropped. Entomologists are not much interested in a poison that might cause cancer—no matter how effective against insects.

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PREFABRICATED — The "monocoque" engineering principle of airplane construction is now being employed in prefabricating houses. By this method the walls are glued to the framing members and become stressed covers carrying part of the weight burden.

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ICE GHOSTS

Difference Between Solids and Liquids is Not Sharp

GHOSTS of ice lurk in water melted from water that has been frozen, and other liquids have some slight residual structure which is like a vague recollection of a former crystalline solid state.

This finding of science was reported by Dr. John G. Kirkwood, professor of chemistry at Cornell University, in a lecture under the auspices of the Society of the Sigma Xi, the national fra-

ternity for the promotion of scientific research.

When a solid melts, Dr. Kirkwood explained, the long-range crystalline order, that extended throughout the whole mass of the solid, disappears completely, but some trace of the short-range local organization persists. Each molecule in the liquid tends to retain a smaller or larger group of its former neighbors about it.

The description of liquids as mobile and formless, and of solids as rigid and resistant to any attempt to deform them, is not a satisfactory distinction. Glasses and other vitreous substances are to be regarded as under-cooled liquids—liquids that have solidified without crystallizing but which under different circumstances would have crystallized. These have strength and rigidity, while true crystalline solids may exhibit creep and plastic flow at elevated temperatures.

Liquids and gases are qualitatively similar in structure and the qualitative distinction vanishes entirely above the critical point. Both possess a certain degree of local order. Crystalline solids, on the other hand, possess a high degree of structural order extending over wide domains.

Only at the absolute zero of temperature is an ideal crystal, possessing complete orderliness, possible. As the temperature is raised, various types of disorder set in, until at last the crystalline structure is disrupted and fusion begins.

MOLDING

Of Plastic, For Use With Linoleum

For use with conventional linoleum and with the wall-lining material designated as Linowall, a new line of plastic trim has been introduced by the Armstrong Cork Company. Included in the line are binding strips, cap strips, inside and outside corners, and right and left-hand end stops. Corners and end stops have floor and wall flanges which extend behind the linoleum to anchor them in place. Installation is said to be simple and the units are available in a range of colors to harmonize with shades of linoleum.

MIMA MOUNDS

Curious "Geological" Formations Turn Out to be Artificial

The origin of "Mima mounds," large oval-shaped structures which dot the prairies of western Washington, and have long puzzled geologists, was explained recently by Dr. Walter W. Dalquest of the University of Washington and Dr. Victor B. Scheffer of the United States Fish and Wildlife Service of Seattle, who gave the solution in the *Journal of Geology* (Chicago).

According to the scientists named, the mounds, some as large as 40 feet across, were formed over a period of thousands of years by generations of pocket gophers.

The Mima mounds—so named from Mima prairie in Thurston County, Washington, where the mounds are largest and most numerous—were first discovered a century ago. Since that time geologists have believed them to be formed by geologic processes.

The mounds, round or oval in shape, are ten to 40 feet in diameter and one to seven feet in height. They are formed of loose dirt and gravel. Thousands are found scattered through western Washington, giving the impression of huge spheres nearly buried in the earth.

The pocket gophers which formed the mounds migrated into western Washington shortly after the last glacial period when the outwash prairies

produced by the melting glaciers were quite smooth. The process of continual burrowing, which loosened the soil and stimulated the growth of vegetation near the burrow, gradually produced the mounds.

The theory is strikingly confirmed by the fact that large rocks, too heavy to be moved by gophers, are found at the base of each mound. This results from the fact that gophers burrow around and beneath large stones, permitting them to settle.

Previous attempts to explain the mounds include the theories that they were formed by the thawing and freezing of water, by the activity of ants, and by ancient Indian tribes.

PHONE HOLDER

Permits Free Use Of Both Hands

Both hands are freed for writing orders, thumbing through files, and so on, while using the telephone, by the use of the Phone Ease attachment illustrated in one of our photographs. This unit, made of molded rubber, fits over the telephone and snaps into place. It forms a shoulder support for the phone when in use, yet rides in the clear in a vertical position when the telephone is returned to its cradle.

"Shoulder — phones!"

FIRE ALARM

Detonates Blank Cartridges To Warn Of Blaze

A simple fire-alarm unit which requires no electric wiring of any kind is designed to be hung on walls in areas where fire may occur. When the air temperature surrounding the unit

reaches 160 degrees, Fahrenheit, sensitive fuses release firing pins which explode two blank cartridges. Through a delayed action built into the unit the second cartridge is fired a few seconds after the first. The first report serves to awaken even the soundest sleeper while the second adds to the realization of danger and aids materially in locating the fire.

The blank cartridges are inserted under the threaded bases of the two firing-pin housings that are attached to the main body of the unit. They are easily replaced after being fired.

STOPS DRIP

Cork Coating For Pipes, Tank, Walls

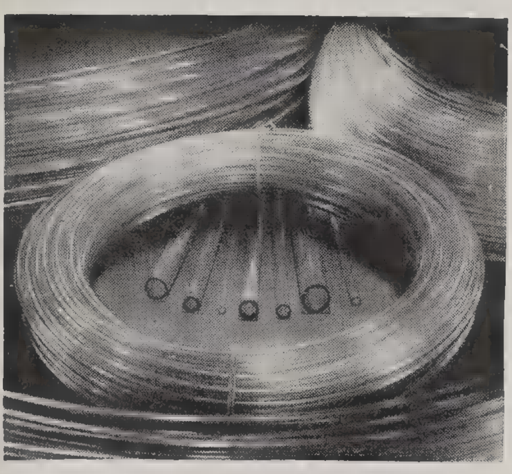
Several months ago there was reported in these columns the development of a plastic cork coating which could be sprayed on pipes, walls, ceilings, tanks, and so on, to prevent condensation drip. This product, marketed under the name of NoDrip, has now been improved in composition to a point where it can be quickly and easily applied by using an ordinary paint brush.

In practice, the cork composition is spread to a thickness of ¼ of an inch over any metal, concrete, tile, or other surface on which condensation tends to form. The cork composition stops dripping from such surfaces and also acts as a protective coating, preventing rust on metal surfaces. It can be painted in any color.

TRANSPARENT

Tubing, Of Plastic, Is Virtually Unbreakable

Easily bent, formed, or curved to fit almost any condition, tubing of transparent Tenite is now available for general use in sizes ranging from 3/16 to ¾ of an inch in diameter. The tubing is seamless and is extruded in continuous



Tubes of tough Tenite

lengths. The Tenite of which it is formed is virtually unbreakable.

The ends of these new plastic tubes may be readily adapted to standard flared fittings with the same tools that are used for copper tubing. Standard thread-cutting tools can be used on the larger diameter tubing, the wall thickness being .0625 of an inch.

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HUMAN EAGLES—The number of civilian airplane pilots in the United States passed the 100,000 mark during 1941. At the close of that year there were 60 percent more civilian pilots than the 63,113 reported the year before.

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RUBBER HEELS

Inspected for Perfection With X-Rays

WITH millions of rubber heels going to our military forces, the necessity for rigid inspection of the finished heels has become even more important. One of the conditions found in defective heels in the past has been occasional misplacement of the steel washers which are imbedded in the rubber heel to hold the nails which attach the heel to the shoe.

Misplacement of one or more of these washers in the heel means that when the nails are driven in, they will have nothing but rubber to hold them in an

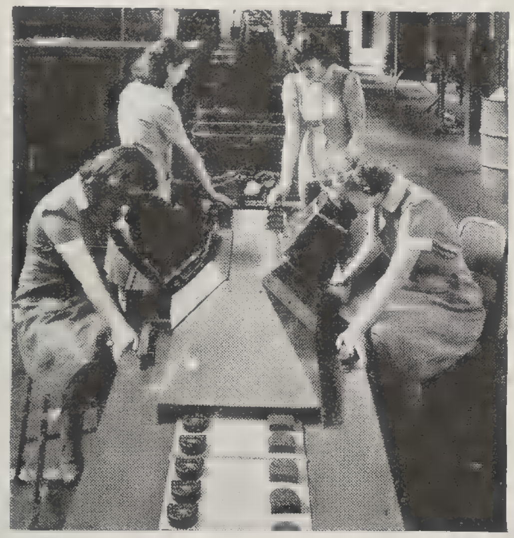
Not acceptable

upright position. Under severe wear they might give way, making the heel loosen and wobble. To make certain that every washer is in its allotted place, The B. F. Goodrich Company has installed new type X-ray machines in its principal rubber heel manufacturing plant.

The stream of rubber heels which comes from the vulcanizers passes through these machines, at each of

which sit keen-eyed, alert girls, their eyes fixed on the moving heels as the conveyor belt carries them under the X-ray eye.

If a single washer is even minutely out of place, so the nail will not go



X-rays detect out-of-line washers

cleanly through it, this machine immediately detects it, and the heel is discarded. The proportion of rejects is minutely small, compared to the flood of products which go under the machine's searching gaze, but the operation of the X-ray machine is one more step in product perfection before it reaches the consumer.

PAPER BLEACHING

Chlorine Conserved by Change in Process

A PROCESS of bleaching paper pulp stock, which promises to reduce substantially the amount of chlorine needed for this important purpose, has as its basic principle the addition of the chlorine to the pulp for bleaching purposes while the pulp is flowing through a piping system and is in a state of turbulence. This method of application, the inventors of the process state, insures a uniform mixture of chlorine and pulp, so that the pulp is evenly treated and the chlorine is used with maximum efficiency. In processes now in common use, some of the chlorine is generally wasted.

An automatic system of chlorinating paper pulp, that embodies the new process, has been developed by the Mathieson Alkali Works and the Gulf States Paper Corporation, working in conjunction. In this automatic system, the rate of feeding of the chlorine is controlled by an air-operated regulator, which varies the amount of chlorine being added in exact proportion to variations in the amount of pulp flowing throughout the entire piping system.

Industrial Growth

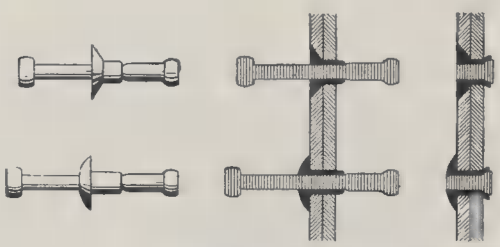
New Products and Processes That Reflect Applications of Research to Industrial Production

BLIND RIVETS

Can Be Set From One Side Only

A NEW type of aluminum rivet for light-weight metal assembly has been developed which can be applied and headed up in locations where the workman has access to only one side of the work. Application and heading up is accomplished with a pneumatic "gun" which completes the operation at a rate of 540 solid rivets per hour or 1200 hollow rivets.

One of our photographs shows the pneumatic gun in operation; the drawing shows two types of solid rivets and indicates the method of application.



Two types of blind rivets

The rivet, before being placed in position, is similar in appearance to the two views at the left in the drawing. Each rivet is a two-piece assembly, the stem sliding on the rivet body proper. The center view in the drawing shows stem and body in position for heading up; the third view gives [redacted] cross section of two completed rivets. These rivets are of the self-plugging type; in a second type the stem falls out of the rivet after it has been used to produce the inside head, leaving a hollow unit in place.

Air gun sets rivets

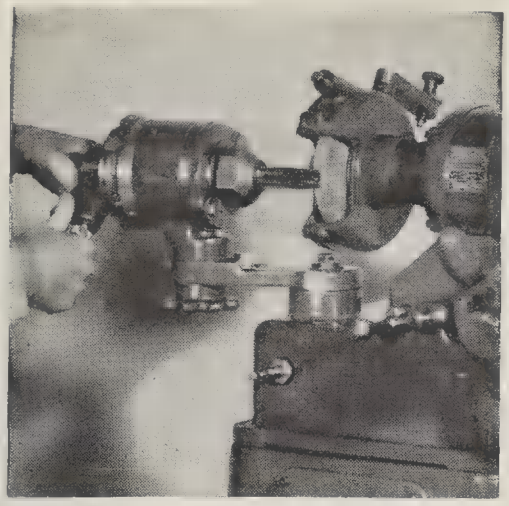
Heading up of these new rivets, called Cherry Blind Rivets, is accomplished by a combination push and pull motion imparted by the pneumatic gun. This tool has a piston which attaches to the head of the stem; an area surrounding the piston applies pressure against the factory-formed head of the rivet to hold it in place. When the gun is operated, the piston pulls the enlarged stem section and finally the head at that end into the shank of the rivet. This movement enlarges the shank and finally forms the head on the opposite side of the work. The stem is then broken off flush and any protruding part is trimmed off with a cutting tool. The rivetting gun used for this work operates on 90 pounds air pressure and exerts a 1300 pound pull on the stem.

TAP RECONDITIONER

Gives New Life to Old Taps

DESIGNED to alleviate current difficulties in securing the vast numbers of precision ground taps required for war production needs, a tap reconditioner has been developed by Detroit Tap and Tool Company. Combining in one unit facilities for chamfering, for spiral pointing and for point polishing, the tap reconditioner serves to eliminate delays in tap replacements by simplifying reconditioning of taps. In addition, the tap reconditioner is said to reduce tapping costs by increasing the output per tap during its useful life. The machine thus also means the avoidance of delays in securing tap replacements by endowing old taps with new life, time after time.

The tap chamfering unit, located at the left of the machine, is of the precision collet type, assuring maximum locating accuracy with quick changes. Taps of from two to seven flutes may be handled through the provision of an indexing drum. Safety stop pins limit the movement of the chamfering unit for taps of different numbers of flutes. A manual type diamond dresser is provided for the chamfering wheel. Hand-



Eliminates tap-replacement delays

wheel adjustment for wear of wheels is provided by mounting the entire grinder assembly on rails.

The spiral pointing unit to the right of the machine employs a saucer type wheel, and its fixture is designed to accommodate taps from the smallest machine screw to ½ inch diameter, using the same precision chuck.

MOTOR

Light Weight, Designed For Aircraft Accessories

A NEW direct-current, explosion-proof motor, built to United States Air Corps specifications, is now being produced in a range of powers from .005 to .2 horsepower, wound for 12 or 24-volt operation. These small units, some of which employ glass insulated wire, are light in weight by virtue of the magnesium alloy frame employed and the use of aluminum bolts, screws, and other small parts.

These motors are being employed to drive airplane accessory equipment, such as fuel pumps, deicers, propeller featherers, and recording and control devices.

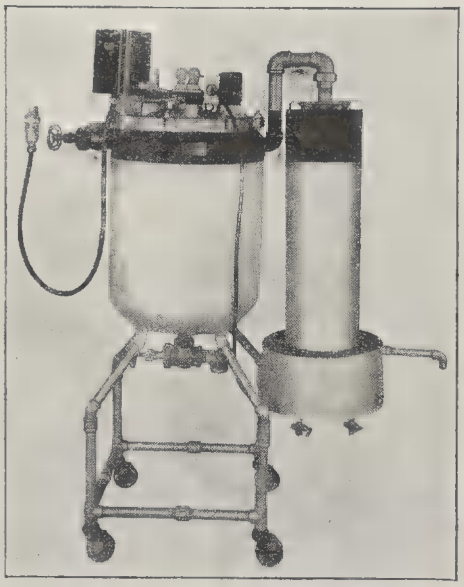
SOLVENT RECOVERY

Made Practical by Air-Cooled Still

THE necessity for full recovery of chlorinated solvents (used principally in vapor type degreasers) in industrial plants, due to O.P.M.'s order M-41 governing the restricted rationing of such solvents, brings a timely development by the Phillips Manufacturing Company of an electrically operated and controlled, fully automatic, air-cooled, portable still and condenser. The unit is constructed to recover perchlorethylene, and can be modified to recover carbon tetrachloride and triclorethylene.

Principal feature of these stills is that all heaters and controls are mounted integrally on the easily removed pot head, assuring easy cleaning and servicing, as well as access to the pot with no fixed fittings on the interior to trap solids.

In operation the still is plugged into a grounded circuit receptacle, and dirty solvent is then pumped or poured into the pot. A sealed float switch indicates by a green pilot lamp when pot is full, and automatically energizes the heaters and starts the cooling fan on the condenser tower. When the liquid level drops to a point just above the heater, the float switch cuts off the heater and pilot lamp until a new charge of dirty



Air cooled; recovers solvents

solvent is placed in the pot. When the oil residues reach a pre-determined specific gravity and temperature, indicating a 98 to 99 percent solvent recovery, the heater is de-energized, and a red pilot lamp signals the operator to dump the residue before filling pot.

The still produces 15 gallons per hour. Operating on single or three-phase, 220 or 440 volts, 60 cycles, A.C., it is classified under maintenance equipment priority rules.

COUNTERSINK

With Adjustable Depth Gage And Center Drill

COUNTERSUNK holes can be rapidly produced to accurate depth for rivets and screws without the need of particular care on the part of the operator through the use of a new unit produced by the Aero Tool Company. A center drill is provided which makes it possible to start holes accurately to punch-marked locations. A micrometer depth adjustment, built into the tool and carrying graduations reading in thousandths, limits the end movement of the countersink.

Jet Propulsion

Italian Experiments With an Airplane That Uses No Propeller for Flight at High Altitudes

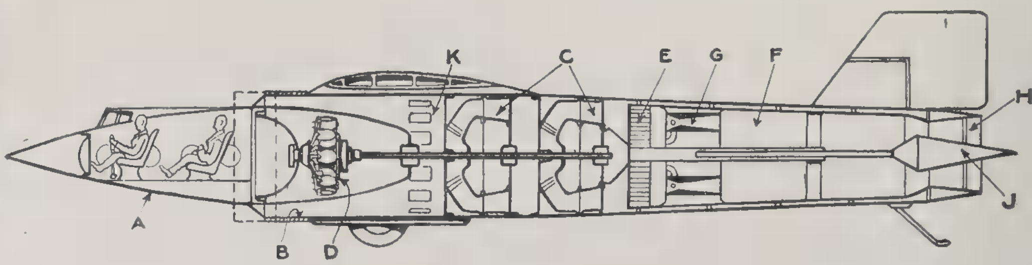
ALEXANDER KLEMIN

Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

We have had occasion to refer to the news from Italy that a jet-propulsion machine has been flown somewhere out of Milan at the Forlanini aerodrome. Somehow or other, *Flight*, of London, has obtained more definite information on the new jet-propulsion aircraft, which is perhaps the very first machine ever flown without an airscrew. It is the conception of an Italian engineer, Campini, and has as its objective the replacing of the orthodox propeller power plant which loses efficiency at high altitudes.

The design of the airplane as a whole is of no particular interest, but the sectional view shown in the sketch illustrates what is of great interest, namely: the principles of the new power plant. At (A) is the front of the cabin in which two occupants are seated; (B) is a cylinder enshrouding the radial aircraft engine. Air is subjected to an initial compression by the forward motion of the aircraft and is additionally compressed by means of two blowers, (C), driven by the engine. The exhaust of the engine discharges directly into the main airstream, adding heat and still further increasing the pressure of the air. At low altitudes, apparently the engine drives an ordinary propeller, and behaves like a conventional power plant. For high altitude flight, a further supply of fuel is introduced into the combustion space (F), into which the compressed air and fuel are guided through (E) and the annular mixing chamber (G). The products of combustion are discharged through discharge nozzle (H), with cone (J) for varying nozzle orifice. The reaction of the jet issuing at (H) supplies the forward thrust. Some reports have it that even at low altitudes, the apparatus can function purely as a jet reaction device.

The above description is not adequate and does not give us information as to the possible efficiency of the apparatus, but in these days of secrecy and censorship, we must be thankful for having even meager data.



Sectional view of the original Campini jet-propulsion plane design

TEMPLATES

Rapid Process Used in Aviation Industry

In aircraft production work, at least one extra copy of a template is always needed and sometimes as many as six may be required. With the conventional hand method, each time a work template is needed, it is necessary to scribe laboriously a duplicate copy of the master layout on a metal sheet, using the master as a reference drawing. The process may require hours, days, or weeks depending on how large and complicated the master drawing may be.

Under a new electrolytic process, developed by Lockheed Aircraft, a work template can be produced in five minutes! There are only three steps in making work templates by the electrolytic process: The preparation of the original drawing by the engineer; the scribing of the drawing on a specially treated metal sheet to make the master layout; and the transfer of the scribed layout to an inexpensive metal copy sheet from which the work template will be cut. The copying operation is routine and can be readily mastered by an unskilled employee. Besides the saving of time, the errors possible with hand work are eliminated.

The electrolytic process may be described as follows: A master layout is scribed from an engineer's drawing on a

piece of galvanized sheet iron of suitable size and thickness, the surface of which has been prepared with a special coating of insulating paint. The lines produced by the scribe are very accurate and extend through the insulating paint coating into the metal surface. The layout thus formed is sprayed with a transfer solution and the wetted surface is pressed into firm and uniform contact with a copy plate. An electric current of suitable intensity is then passed between the plates, resulting in the layout on the master plate being transferred to the copy plate. At the end of a few seconds the press is released and the two plates removed, separated, washed, and dried. The copy plate is given a thin protective coating and is then ready for immediate use by the template cutters. Any number of copies can be made from the master plate, and, if the press is large enough, a 48- by 144-inch plate can be used. The cost of templates produced by this method is extremely low. Almost any hydraulic press may be put into service for the work.—*A. K.*

MULTIPLE MOWER

Keeps Grass on Air Fields in Proper Trim

With the enormous number of air fields to be put in service by the Army and Navy, concrete or other hard runways become peace-time luxuries and, because they have high visibility, invite bombing attacks. Properly conditioned turf becomes of great importance. But the rub lies in the words "properly conditioned." How can an enormous field of say 500 acres be kept in condition? The modern golf course equipment using a seven-gang mower cannot be operated at speeds exceeding six miles an hour and at this speed can only cut 11 acres an hour or 88 acres during an eight hour day. That would mean five and one half days to trim a 500 acre flying field.

To meet the difficulty, the engineers of the Worthington Mower Company have developed a gang mower hauled by a fast and powerful tractor which operates efficiently at 20 miles an hour. At this speed the mower has the enormous capacity of 368 acres in an eight hour day.

The mower is shown in our photograph and it involves many new principles. Heretofore all types and styles of cutting units have established the height of cut from the ground up. On rough air field conditions at high speeds the rollers and casters transmitted all shocks, jars, and vibrations to the cutting unit. In the new framework, the rear of the cutting unit is

Airport grass must be dense

suspended from the frame and the height of cut is regulated through this suspension so that nothing touches the ground except the large pneumatic rubber traction tires. The increased simpleness of operation can be readily understood thereby.

A thick, dense turf is helpful on an airfield because it covers loose particles of stone, gravel, and so on, which are a source of considerable danger to metal propeller tips. A thick, dense turf also helps to absorb rainfall but a thick, dense turf is only developed by frequent cutting. Hence, the great advantage to be derived from the new, high-speed mower.—*A. K.*

FLIGHT CLOTHING

Being Developed for Alaskan Use

Alaska is going to assume increasing importance in our operations against Japan and it is obvious that flight clothing used during the Alaskan winter must give protection both inside the airplane and while walking outside away from an electric outlet.

Therefore, both heated and unheated clothing is being developed in the Equipment Laboratory of the Materiel Division of the Air Corps at Wright Field. Unheated suits have been made of various types of insulating materials such as furs and quilted down. Electrically heated units meet the requirements of temperatures as low as —60 degrees, Fahrenheit. The heated suits are apparently worn as underwear beneath light flying clothes or a coverall. One type uses a coiled wire heating element; another type eliminates 95 percent of the wire by using a carbon impregnated material which conducts the current through the material itself. The regulation is obtained by changing electrical resistance. Heated gloves and shoes are used with the suit. It is even claimed that the heated suit, gloves, and shoes provide sufficient heat inside an unheated cabin to eliminate frosting of the windshield.—*A. K.*

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Spotlights Solve a Problem

CONTAINED in a shipment of rough diamonds received by Reinhold Brothers, New York City, from an African exporter, was a rough diamond less than a quarter of an inch in diameter. It was distinguished from the other diamonds by the fact that on one of its faces was engraved the letter "V." This was quite a find, so the importer asked us to make a picture of the diamond showing the engraved V as clearly as possible.

That was easier said than done, even though on the surface it seemed like a simple job of cross-lighting. The problem was to light the tiny walls of the letter with sufficient brightness to make them prominent, at the same time creating a dark background for the letter *within* the glass itself. The subject was not to be tampered with in any way; the job was to be done entirely with light.

A "V" in the rough

To obtain a fair magnification of the stone, we used a 5 by 7 view camera, its bellows extended the full 19 inches, equipped with a 6-inch Dagor lens. Reaching as close as we could with this set-up, we obtained a fair magnification, later enlarging the diamond image to a diameter of a little more than 1½ inches, even though the Super Ortho Press film we used was developed in 1-to-1 D-72.

The lighting arrangement took two or three hours, believe it or not, because the clean-cut result we strove for did not come as easily as we had thought it might. We used from one to three spotlights, these being employed because of the great control possible, placing the spot-focus beam as nearly on a line with the stone as possible. The idea was to shoot the light through the side of the stone. We found, eventually, that two spots, the direction of which may be seen from the position of the shadows in the illustration, would do the trick better than one or three, the first not being sufficient to bring up sharply both lines of the letter, and the second tending to flatten the crispness obtained by using two spots.

The letter V formed by the two shadows is purely accidental but helps the subject.

Are Flash Bulbs Scarce?

RECENTLY an ugly rumor went the rounds that there were to be no more flash bulbs, at least not for a very long time, because the Government needed the aluminum. However, the veil has been lifted and it appears that an order had gone forth freezing distribution of flash bulbs temporarily. Now the order has been lifted and flash bulbs are again available, though the supply is not inexhaustible. In any event, we can take nothing for granted. The war is still on, and freezing orders may come again. The general advice is to behave, buy only in normal quantities and thereby show the Government that you will use flash bulbs economically and not in the profligate manner we have been accustomed to when things were different a short while ago. In that way, sufficient materials may come through to make it possible for the manufacturers to keep the amateur and professional supplied.

Reducing Static in Darkroom

SPRAYING moisture into the darkroom air through an atomizer helps to reduce the presence of static, which is the cause of lint and dust adhering to the surfaces of negatives. If you have been having trouble on this account, try this atomizer stunt and see if it helps.

Large vs. Small Cameras

THEY say larger cameras are coming back. The illustration shows one lad who is bringing them back in a big way; a 5 by 7 Graflex, no less! There is considerable talk on the subject of miniature versus larger cameras, but it is surprising how many persons still think highly of the 35mm minia-

Staging a come-back?

ture, believe it is superior in many ways to the larger cameras. The general feeling, however, seems to be that the $2\frac{1}{4}$ by $2\frac{1}{4}$ negative is the smallest feasible, yet the admission is frequently made that the miniature—because of its small, compact size—is still the camera par excellence for candid work and wherever it is advantageous to keep the camera on one's person most of the time.

Sound Films Train Workers

Workers in armament production are being trained through the medium of sound films produced under the direction of the U. S. Office of Education, Federal Security Agency. Of the 50 reels of film comprising the program, 18 have been completed and are now being reproduced in 16mm size, according to Castle Films, Inc., which was awarded the contract for distribution.

"The U. S. Office of Education has produced a series of motion-picture films dealing with mechanical skills and knowledge, expressly designed to be used by vocational teachers and shop instructors," said Dr. John W. Studebaker, U. S. Commissioner of Education, in describing the purpose of the films. "These films will assist potential and employed defense workers more rapidly to learn and more thoroughly to comprehend the instruction being given them in the vocational schools throughout the United States."

Following a detailed course in the handling of machine tools in precision work, 40 of the films cover the subject of machine-shop practice. Seven reels are devoted to the engine lathe, five to precision measurement, five to the vertical boring mill, five to the milling machine, five to the use of drill presses of various types, seven to bench work, three to the shaper, two to the action of single point cutting tools, and one to centering and layout. Operations in ship building are covered by 10 more films, still in production.

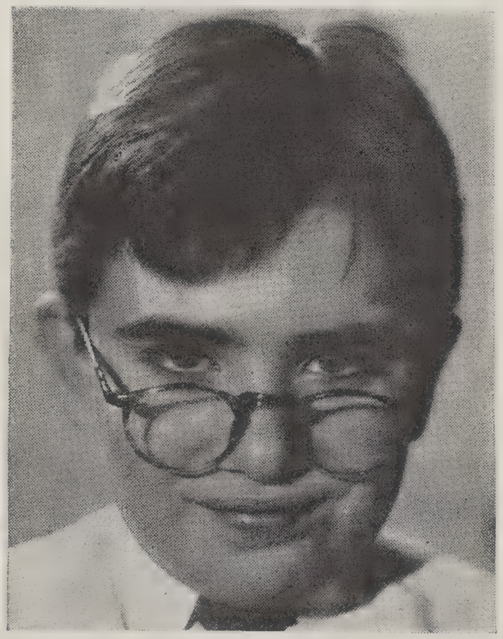
Slide-Binding

Color transparency slides may now be bound in about the same manner as prints are mounted in a dry-mounting press. A completely new departure in the field of slide-binding, the method is made possible by a vise-like affair containing a heating element. The slide is inserted, as usual, in a paper mask called "a scientifically prepared thermo mask," and then between two pieces of 2 by 2-inch glass. The assembly is held together with a small clip, no tape or frames being used, and then fed between the flat jaws of the vise, the bottom surface of which is electrically heated. The jaws are slowly brought together and allowed to remain thus for about 30 seconds, at the end of which time they are separated by pushing down the lever and the slide is complete, firmly held together by the adhesive with which the mask is impregnated.

No tape, no frames

Make 'Em Clown

Don't take on too serious an attitude when you're shooting a child's picture. It scares the child into awkward, stiff poses and expressions, with the result that the pictures you get lack life and naturalness. Try making them clown; that is, let them mimic whatever or whoever they think is funny. Children have their own sense of humor, which adults often fail to appreciate. But if you will try to put yourself in the child's place, forget that you're grown up, make believe you're a child again, you will see pictures even when the child clowns. Some of them will be very bad; many will be very good because they are spontaneous and because the child is unconscious of the camera. The boy in the illustration expressed a wish to wear glasses and imitate a grown-up. The photographer complied and the subject was happy. So is the result, we think.



Smile, and subject smiles, too

Correction

In the item "Print Reducer" which appeared on page 208 of our April 1942 issue there was an error in the formula given. Solution A of the reducer should consist of 200 grains of sublimated iodine and 10 ounces of alcohol, not 20 ounces of sublimated iodine and 10 ounces of alcohol as was originally stated in these columns.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

FIRST PRINCIPLES OF FLIGHT

By D. Hay Surgeoner

ALTHOUGH the text of the present book is prepared from the British viewpoint, the information presented is of such fundamental nature that a perusal of it will serve to give a satisfactory foundation for the average reader who wants to know a little more about the "why" of flight. The chapter titles indicate the scope of the work: The Atmosphere, Fluid Motion, Aerodynamics, Practical Considerations, Stability, Control, Airscrews. (108 pages, 5 by 7½ inches, a number of line drawings.)—$1.30 postpaid.—*A. P. P.*

DEAD MEN DO TELL TALES

By Byron de Prorok

RACY, lively account of the travels of a noted archeologist-explorer, mainly in the region of Ethiopia before the momentary conquest by Mussolini. To readers of scientific leaning the anthropological sidelights on primitive peoples will be of significance. In Ethiopia the author met and hobnobbed with Hailie Selassie. The book abounds with exotic adventure and will be difficult to put aside until finished. (328 pages, 6 by 9 inches, 19 illustrations.)—$3.60 postpaid.—*A. G. I.*

SOUTHWESTERN ARCHEOLOGY

By John C. McGregor

ORGANIZED groundwork on which the student—amateur or professional—may build his knowledge of the rapidly advancing discoveries in Arizona, New Mexico, south-west Colorado, Utah, parts of Nevada, California, and northern Mexico. This work is likely to become outstanding—a landmark—among archeologists. (403 pages, 6¼ by 10 inches, illustrated.)—$5.10 postpaid.—*A. G. I.*

PHOTOGRAPHY, ITS SCIENCE AND PRACTICE

By John R. Roebuck and Henry C. Staehle

AFTER an amateur photographer becomes thoroughly familiar with the operation of his equipment and has thoroughly grasped the technique of photography, he frequently wants to delve into the fundamental science of this subject. It is for this ever-expanding group that this present book is intended. The text surveys the modern science of photography, presents a brief sketch of the historical developments, and then gives detailed attention to the properties of photographic materials, the factors determining correct exposure, and the sensitivity to color needed to preserve tonal values. This is followed by a consideration of the chemical processes of development and of the positive processes such as printing, enlarging, and making slides. A chapter is devoted to the latent image theory and another to lenses and the optical aspects of photography. Color photography is fully discussed and a section of the book gives a concise presentation of the subject of composition and other aids in making good pictures. A "laboratory manual" presents a series of practical experiments. (283 pages, 6 by 8½ inches, 96 illustrations.)—$5.10 postpaid.—*A. P. P.*

BOATBUILDING

By Howard I. Chapelle

SO far as this reviewer can ascertain, this is the most complete book on boatbuilding. It isn't for the greenhorn; the user should already know things about boats and tools. It was written in detail because the magazine articles usually skip the parts a designer and builder most needs to know. This book, by a well-known builder, is a practical shop book, no mere armchair companion. It stresses especially mold loft work—laying out beforehand in full size—the lack of which so often lands landlubbers in jams. The craft employed as examples are all sailing craft, and many are Chesapeake Bay types, but the principles explained in so much detail are basic to all types. (624 pages, 6 by 9¼ inches, 186 illustrations.)—$5.10 postpaid.—*A. G. I.*

NOSTRADAMUS SEES ALL

By Andre Lamont

THE author, born in the Orient, educated in Europe and America, known for his articles on astrology, the Kabbala, and various methods of reading character, utilized all available books on Nostradamus—many rare and in several languages—plus the Houdini collection, and other original source material to present this volume of interpretations of the prophecies by Nostradamus, the 16th Century astrologer. Also, a comprehensive and interesting biography of the medieval physician who foretold World War I, the rise of Communism, Fascism,

Nazism; the emergence of Stalin, Mussolini, Hitler, Franco, Churchill, Roosevelt, Petain, and others. (341 pages, 5 by 7½ inches, illustrated.)—$2.60 postpaid.—*A. D. R., IV.*

TIME AND TIMEKEEPERS

By Willis I. Milham

RE-ISSUE of a book dated 1923, now available at greatly lowered cost and, even today, out of date only in minor degree, but a book which still has no equal in the sense of its "all-aroundness." Author is Professor of Astronomy at Williams College and the subject is his scientific hobby. The book covers the whole field of the history, construction, care, and accuracy of clocks and watches, without assuming previous knowledge on the reader's part. Aspect most emphasized is the history of early clocks and watches. A book for other hobbyists. (616 pages, 5½ by 8⅜ inches, 339 illustrations.)—$2.10 postpaid.—*A. G. I.*

DANA'S MANUAL OF MINERALOGY

Revised by Cornelius S. Hurlbut, Jr., Ph.D.

FIFTEENTH edition of a standard work of great prestige, prepared by professor of mineralogy at Harvard. Standard text and reference. Covers crystallography (hard labor), also physical, chemical, descriptive, and determinative mineralogy, that corner of geology dealing alone with the description, classification, and correlation of mineral species. Is solid meat, no concessions to entertainment but would be entirely suitable for amateurs who want reliability and aren't afraid of study. (480 pages, 6 by 9 inches, 436 illustrations.)—$4.10 postpaid.—*A. G. I.*

THE LATHE MANUAL

By The Staff of the Metal Trades Department of the William Hood Dunwoody Institute

JOBS on the engine lathe, the turret lathe, and the hand screw machine are thoroughly covered in the mimeographed text of this volume. In addition, the reader is shown the common methods of laying out work for center drilling and for grinding lathe tools. The text is prepared as a course of instruction for beginners in machine-shop technique and as such has been proved effective by use in industrial and trade schools. (143 pages, 9 by 11 inches, thoroughly illustrated.)—$1.45 postpaid.—*A. P. P.*

DON'T BE AFRAID

By Edwin Spencer Cowles, M.D.

ANXIETY, apprehensiveness, usually from no known cause, but vague and general, afflicts many persons who do not know that this often is a symptom. Emotional instability, irritability, easy fatigability, palpitation, often accompany it. Neurasthenia, even suicidal melancholia, sometimes follow, if the cause is not removed; and the cause, according to the theory of this layman's book, on which the author, who is director of the Body and Mind Clinic, also the Park Avenue Hospital, New York, has based his life work of healing, is fatigue, often not realized, which lowers the body's defenses against fears and phobias. Many of us Yankees harbor anxiety complexes which may have this basis. (229 pages, 5½ by 8 inches, unillustrated.)—$2.10 postpaid. —*A. G. I.*

HOW TO MAKE YOUR OWN FURNITURE

By Eugene O'Hare

DETAILED—some, unless beginners, would think too detailed—instructions for making a bookcase, a couch end, a desk and bench, a table, a coffee table, a dressing table, a picture frame, a magazine rack, a hinged-top chest. Not fancy cabinet work and not soapbox carpentry, but intermediate. The types are all modern, not period. (94 pages, 8½ by 11 inches, illustrated.)—$2.60 postpaid.—*A. G. I.*

UNIVERSAL PHOTO ALMANAC 1942

Louis H. Lanctot, Editor, and Jacob Deschin, Technical Editor

MANY photographic problems will be solved by the article text and illustrations presented in this latest edition

of a photographic annual which has come to be looked upon as one of the standards in the hobby. Sixteen articles cover various phases of photographic technique. A formulary section gives complete information on developing, printing, and toning, as well as on film speeds, paper speeds, flash exposures, and so on. The pictorial section presents 26 reproductions of salon exhibition prints by famed photographers. The Market Guide lists a thousand names and addresses of organizations which purchase free-lance photographs. The bibliography lists photo trade magazines and current photographic books. (270 pages, 6 by 9 inches, numerous illustrations.)—$1.10 postpaid.—*A. P. P.*

MODERN AMERICANS IN SCIENCE AND INVENTION

By Edna Yost

INSPIRATIONAL book, not for youngsters but for young men seeking to set worlds aflame. Accounts of careers of Cornell (telegraph), Appleby (knot-tying device), Smith (father of health laws), Brashear (famous precision optician), Ambrose Swasey (machine tool builder), Gorgas (Canal Zone), Wiley (pure food), Sperry (gyroscopes), Carver (Tuskeegee), Baekeland (Bakelite), Carrier (air-conditioning), Kettering (inventions), Cottrell (precipitator), Williams (vitamins), Zworykin (electronics), Truog (soils). Author was once with A.S.M.E. (270 pages, 5½ by 8 inches, unillustrated.)—$2.10 postpaid.—*A. G. I.*

HOUSE CONSTRUCTION DETAILS

By Nelson L. Burbank

SECOND and revised edition of a successful book published three years ago. Amateurs who are tool-handy, but uncertain about detailing the steps in putting together their design of a house, will find here the crutch that complements them. It abounds in details, mainly drawings, of how the many parts go together. Chapters on: plans, foundations, roofs, stairs, wiring, insulation, and other details; also on cabins, cottages, farm buildings, painting, heating, and other work. (313 pages, 8½ by 11 inches, heavily illustrated.)—$3.10 postpaid.—*A. G. I.*

BENJAMIN FRANKLIN'S EXPERIMENTS

Edited by I. Bernard Cohen

FRANKLIN'S own accounts of his experiments and observations on electricity have long been inaccessible because publishers were mainly interested in his political and diplomatic aspects. Millikan rates him as one of only 14 most influential men in the whole of science since 1473. The editor, a scholar working under auspices of Carnegie Institution of Washington, here presents wise old Ben's original, unaltered writings so that the reader may study his keen mind at work on electricity. (453 pages, 5½ by 8¼ inches, 4 illustrations.)—$4.10 postpaid.—*A. G. I.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

How Small Industries Can Go After War Work is a 20-page pamphlet which tells how industries can secure loans for equipment to make war armaments, how small companies can form pools to obtain contracts, and other helpful data of value under present conditions. *Copper and Brass Research Association, 420 Lexington Avenue, New York, New York.—Gratis.*

Construction Glues is a large folder which presents, partly in question-and-answer form, pertinent facts regarding the use of glues in the building field—in prefabrication and in laminated arches and beams. A number of photographs show varied application. *I. F. Laucks, Inc., 911 Western Avenue, Maritime Building, Seattle, Washington.—Gratis.*

Osgood Mobilcranes is a 12-page fully illustrated booklet describing different types of cranes, mounted on pneumatic tired chassis, which are powered with only one engine and operated by only one man. This one operator can control all the motions of the crane, including traveling.—*The Osgood Company, Marion, Ohio.—Gratis.*

Laboratory Rheostats is a four-page circular describing "Lubri-tact" instruments which have many important applications in industry. One of the distinguishing features of these instruments is a graphite lubricated contact which eliminates wear and makes smooth adjustment possible. *Request bulletin 1705. James G. Biddle Company, 1211–13 Arch Street, Philadelphia, Pennsylvania.—Gratis.*

Pressure-Treated Wood for Permanent Low Cost Housing is an illustrated leaflet showing those parts of buildings which need protection against decay and fungus, and suggested treatments for painted and unpainted wood. *Wood Preserving Division, Koppers Company, 2000 Koppers Building, Pittsburgh, Pennsylvania.—Gratis.*

The Care and Use of Electric Appliances in the Home is a 32-page indexed booklet which tells housewives how they can help in the present national emergency by the efficient use and proper care of their electrical apparatus. It also contains food buying and menu suggestions, as well as housework short cuts. *Westinghouse Appliance Dealers or direct from Westinghouse Electric and Manufacturing Company, 40 Wall Street, New York, New York.—Gratis.*

Handbook for Drillers is a 48-page illustrated manual prepared especially for students in war production work, yet of equal interest to anyone in any way concerned with modern and standard shop practice. It gives an introduction to the theory underlying the use of the twist drill and considerable data on speeds, feeds, and general operation. Exceptionally well illustrated. *The Cleveland Twist Drill Company, 1242 East 49th Street, Cleveland, Ohio.—Single copies gratis. Price on quantities on application.*

Ideal Quality Transmissions is a 52-page handbook which includes recommendations, application data, photos, and engineering information on variable speed pulleys and transmissions. The data presented are of interest to design engineers, mechanics, purchasing agents, and so on. *Ideal Commutator Dresser Company, Sycamore, Illinois.—Gratis.*

Industrial Research in the United States During 1941, by William A. Hamor, is a 36-page reprint that covers in considerable detail the subject of its title. Industries treated in this study run the whole gamut from coal to ceramics, from glass to chemistry, from metals to agriculture, and so on. *Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pennsylvania.—Gratis.*

"Dustube" Dust Collectors is a 58-page pamphlet prepared as a manual to serve plant engineers and officials in the selection of proper control equipment for specific dust problems. It includes practical and essential data for efficient operation of dust control systems, technical layouts and engineering tables and charts for use in planning applications of dust control units. Catalog No. 72. *American Foundry Equipment Company, Mishawaka, Indiana.—Gratis.*

The Wreckord is a 36-page analysis of the facts about street and highway accidents in which 40,000 persons were killed and almost a million and a half were injured in 1941.—*The Travelers Insurance Company, Hartford, Connecticut.—Gratis.*

"Trans-Ceiver" is a four-page leaflet describing a four-pound combination ultra short-wave, self-contained radio transmitter and receiver. *Weltronic Corporation, 3080 E. Outer Drive, Detroit, Michigan.—Gratis.*

Metal Duplicating Without Dies is a 32-page engineering catalog which describes in detail a simplified system for expediting industrial and military production. The system involves a series of standardized shop units that, almost universally adjustable, will often take the place and do the work of dies, jigs, and fixtures. Many defense plants are speeding up their work by applying this system to short-run requirements. Request this bulletin on your business letterhead. *O'Neil-Irwin Manufacturing Company, Minneapolis, Minnesota.—Gratis.*

Airport Lighting is a 42-page bulletin which covers the lighting and electrical distribution equipment involved in the design of an airport. Typical layout plans with C.A.A. recommendations are given. Photographs and brief descriptions of all necessary floodlights, beacons, contact and boundary lights are included. Bulletin B-3046. *Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.—Gratis.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

IN his astronomical article, page 230, Professor Russell states that the principal instrument possessed by the newly inaugurated Mexican National Observatory is a Schmidt camera of 24" effective aperture, and he stresses its great value to astronomy. Amateur telescope makers are also keenly interested in the constructional side of any such instrument, and the Perkin-Elmer Corporation, now in a bright and shining, newly-built plant at Glenbrook, Connecticut, was therefore invited to submit a brief note for these pages. The note:

"When the Mexican Government contracted with the Perkin-Elmer Corporation for a large Schmidt camera, the aperture was specified as 24". The very outermost zones of a corrector plate, however, do not come to proper curve by the treatment which is best for the inner zones. In the case of a 24" Schmidt previously made by this company for the Harvard College Observatory, the plate was not oversized, and consequently the edge zones delayed the final figure. For the Mexican instrument, therefore, Halley Mogey, Chief Optician, requested a larger blank, so that the 24" clear aperture could be obtained in the least time. The grinding and edging operations were directed by T. J. La Lime, head of the grinding department.

"Although the curve on this corrector plate is imperceptible to the eye (the focal ratio is $f/3.5$), the difference between it and a perfectly flat plate is an amount of glass as big as a lump of sugar (about a quarter of a cubic inch) all removed by polishing alone.

***Figure 2:* La Lime and 31" mirror**

"Both the knife-edge and the Ronchi grating were used in the test set-up, which involved auto-collimation from a flat mirror and the use of a small periscope for looking at the image without obscuring much of the beam. When the mirror and plate were completed, no errors at all could be seen under this test over at least a 24½" aperture."

The three shop photographs, Figures 1, 2, and 3, were furnished at our request by Richard Perkin. They were taken by the former amateur telescope maker, Robert E. Cox, who a year or two ago "went professional" with the Perkin-Elmer Corporation; another former amateur employed there being Daniel E. McGuire who similarly went professional several years ago. Amateurs are now in so many professional optical shops that this department finds it almost impossible to draw a line between the two. There actually is no such line; it has been washed out. Most of the professionals were amateurs at one time.

Figure 1 shows the 31" Schmidt mirror disk in the last stage of emery before polishing. The machine itself will also interest our readers. So will chief optician Halley Mogey, who stands beside it. (Some

***Figure 3:* Mogey's expert digit**

day this department may publish a series of personality articles on prominent people in professional optics.) Your scribe believes Halley Mogey's name never is mentioned without the inevitable after-question, "Was he named for Halley's Comet?" Halley Mogey really *was* named for Halley's Comet. What was more logical—his father a telescope maker and the two arrivals coinciding? The boy grew up in his father's shop at Plainfield, N. J. (now run by another son, William Mogey, assisted by Messrs. Brown, Lojas, and Grosswendt, all former amateurs). There he gained the "feel" of glass and abrasive. Then he went off to college and gained theory, and returned equipped on both sides, practical and theoretical, to make maximum application of the mind-and-hand team. When Schmidts came along, a few years ago, he went to the Mt. Wilson optical shops to learn special Schmidt technique; and left there some of his own. In Figure 1 he is seen in shop clothes. A good optician, no manner how much theory he has in his head, never is too lofty to get into working pants and use his hands.

Figure 2 shows the same 31" disk fine-ground, with T. J. La Lime, head of the grinding department, measuring the radius of curvature with a spherometer.

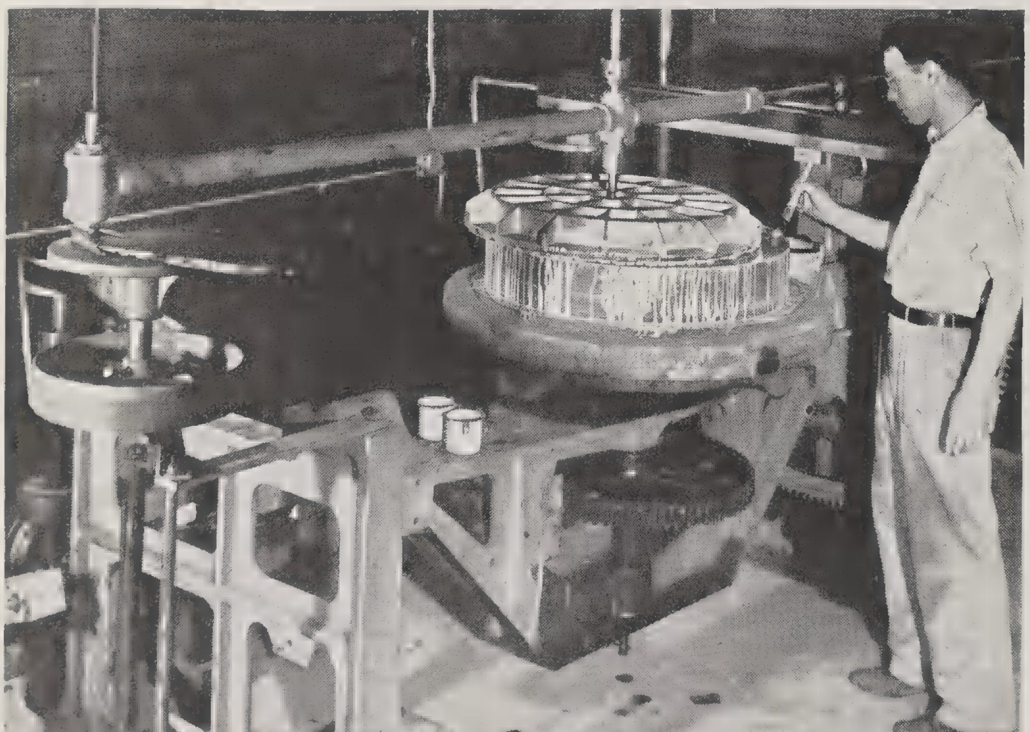


***Figure 1:* Machine, mirror, Mogey**

***Figure 4 (right):* Schmidt evolution**

In Figure 3, Halley Mogey is hand-touching an outer zone on the 26" corrector plate of the Schmidt camera. Some years ago amateurs argued whether the tradition that the old-time professionals used their hands as a "rubber" (as non-telescope making persons styled it) for local touching, was true or just a story. While some argued, others tried it, and it worked. Since then it has been amply proved by other evidences that the old-timers did use this method; the popular tradition was quite correct. Besides, the method is not in any way remarkable; simply, instead of a small tool of pitch, a small tool of fine leather is used—that is, the hand or whatever part of the hand is the user's own pet method. In Figure 3 you see this method in the flesh. This photograph, now published, will be useful to show to occasional doubters about hand touching among professionals.

No clearer, simpler, more direct explanation of the working principle of the Schmidt camera has been seen by this department than one found in a booklet describing the newly added equipment at the Warner and Swasey Observatory of the Case School of Applied Science at Cleveland. The drawings from the booklet are reproduced in Figure 4, and here is the explanation:

"In 1931 Bernhart Schmidt, an optical worker at the Hamburg Observatory in Bergedorf, published an account of a reflecting telescope free from nearly all the inherent defects common to such instruments. This was accomplished by introducing a thin lens in front of a spherical mirror.

"His reasoning was clear and logical, in spite of the fact that he avoided all mathematics. He ended his article by stating: 'The method of producing the lens is assumed.' In other words, he was not going to reveal the secret, a characteristic common to optical workers, particularly of the past.

"It seems that the first Schmidt telescope was completed in the summer of 1930, when Schmidt and a friend amused themselves by reading the epitaphs on the tombstones in a nearby cemetery. A remarkably detailed photograph of a windmill a mile and a quarter away, made with his first telescope during a moonless night, is now of historic interest.

"In 1936, Dr. R. Schorr of Hamburg Observatory finally disclosed the secret of how Schmidt, who had died in 1935, had produced the surface of the all-important lens. Schmidt placed a plane-parallel disk of glass on the open end of a circular cylinder of nearly the same diameter and evacuated the cylinder until the desired bending of the glass disk was secured. Then he polished the glass surface to a perfect plane. After allowing the air to re-fill the cylinder, the plane polished surface took the desired form of the lens.

"The Schmidt-type telescope employs a spherical mirror instead of the usual parabolic mirror of the reflector. Parallel rays incident upon a spherical mirror do not come to a focus at the same point. The rays striking the center of the mirror come to a focus at a point *F*, midway between the mirror and its center of curvature; while rays striking the outer zones come to a focus somewhat nearer to the mirror.

TELESCOPTICS

"If, however, we make the light striking this outer zone slightly divergent, all the rays can be brought to a focus at *F*. This is accomplished by placing a thin lens in front of the mirror and at its center of curvature. The shape of such a lens is shown in the second diagram.

"This results in the combination in the third diagram.

"The same results may be accomplished by introducing at *R* a lens with a shape shown in the fourth diagram.

"In this case, the outer rays are less divergent and the center rays slightly convergent. The resulting combination, with the focus now a little closer to the mirror, is shown in the final diagram.

"If the parallel rays are directed to the telescope from an angle different from the one shown in the above figures, they will again come to an exact focus. This is due to the fact that the mirror is spherical and has no axis, and the lens is at the center of curvature of the mirror. The optical system thus remains exactly the same as before.

"The bundles of parallel rays striking the mirror from all angles will thus be focused on a photographic plate bent into a slightly spherical surface. In practice it is easy to bend ordinary flat photographic plates into the necessary spherical form.

"Stated in another way—rays of light entering the telescope from stars widely separated in the sky will be brought to an exact focus; a condition not realized in the usual reflecting telescope. Thus a large area of the sky may be photographed at one time.

"Since the lens employed is relatively thin, it produces an instrument which is free from the color defects associated with refracting telescopes. Also, since the focal ratio of the telescope can be made small without sacrificing other desirable properties, the instrument is 'fast' in the same sense as the word is used with respect to cameras.

"The wide-angle field, the achromatic properties, and the speed, are the three principal advantages of the Schmidt telescope."

The new Schmidt camera at the Warner and Swasey Observatory has a 36" Pyrex mirror of 14' radius of curvature, with a 24" lens of Vita-glass, .3" thick. Maximum departure from a plane is .0005" and the optical work was done by C. A. Lundin of the Warner and Swasey Co., Cleveland, Ohio.

BEFORE the beginner has picked up from here and there a modicum of general background about telescope principles he is almost sure to run up at least one blind alley in pursuit of a beautiful illusion. Your scribe, for example, in 1924, when quite innocent of telescoptical background, saw a picture of a group of reflectors made by the Telescope Makers of Springfield, Vermont. One of them was short, chubby, compact, unlike the others. Obviously that one would be *much* better, hence the one to make. Now it happens that a short chubby telescope (short focal ratio) is an ideal one for the tyro not to make, because the curve of the mirror is much more difficult when deep—more advanced work. Russell Porter explained this fact and your scribe desisted.

On the opposite extreme are telescopes having great length—long focal ratio—and when the tyro discovers that these give high magnification he is inclined to plump for one as his first job. These, however, are a headache in other ways. As John Pierce puts it: "Made a 4" of 90" focal length with very poor results so far as comfort in observing goes—hard to point—diagonal large and field necessarily small, since the large-lens eyepieces are not available."

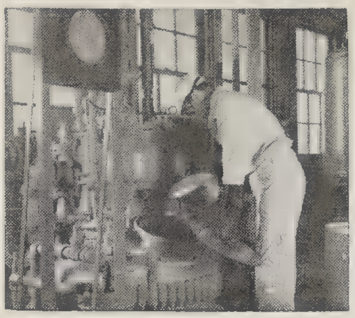
Commenting on a tyro's proposal to make a "high-magnification" telescope with focal ratio 40, Alan R. Kirkham made apposite observations in an old letter dug up by your scribe from the lower, or pre-Cambrian, strata of his desk (had a house-cleaning):

"Focal ratios of longer than $f/20$, which itself is extreme, cannot be recommended because they do not give full fields with any but eyepieces whose magnifying power is above most practicable limits. The focal image of the Moon in a telescope of 6" aperture and focal ratio of 40 is big—about 2.088" in diameter—it is true. However, compare the size of the field lens of a 1" eyepiece with this and see how miserably small the field actually seen will be. In order to get down within the magnifying power universally agreed to be best for seeing, about 16 diameters to the inch, or perhaps 10 to 20 diameters depending on various factors, we require a 2½" eyepiece with such a telescope. Good eyepieces are easily designed for a useful field of 40°, but the ability to give this apparent range depends on the field lens being large enough to receive all the rays of 40° magnification. The condition is met with in all eyepieces of about 1¼" focus, down. A 1½" eyepiece needs a field lens 1⅛" in diameter, a 2" eyepiece one of 1½" diameter, and a 2½" should have a field lens about 2" in diameter. These 'out' sizes are hard or impossible to find—it's about like asking for a size 22 shoe at a shoe store. In a nutshell, we get only a narrow field, caused by the telescope itself having wrong proportions. Moreover, these eyepieces would have great spherical aberration. They also require several inches of rack and pinion work for focusing from the longest to the shortest of them, and require diagonals of too great size. They also suffer from curvature of field.

"If that is not enough, there are other reasons why the existing range of eyepieces became more or less standard—for it didn't just 'happen.' The long focal ratio takes a very long and awkward tube, and this means trouble in keeping the optical elements in alinement. Besides, try figuring an $f/40$ mirror—I did. Just like looking at the head of a pin. Diffraction effects are very great, and the mirror even seems to move around with the motion of the eye. In focograms, such mirrors are surrounded by a diffraction edge half the radius of the mirror itself. Finally, the image is poorly illuminated."

Persons who urge the beginner to adopt conventional designs in anything, just because these designs are conventional are, of course, simply gratuitous irritants; but on the other hand there often—though not always—is some sound reason behind a convention, representing the experience of those who came before.

Printed at Williams Press, Albany, New York, U. S. A.



PROGRESS in the chemical industry, dealt with in detail on page 278, is symbolized by our front cover photograph, taken in a plant of the Calco Chemical Division, American Cyanamid Company, of one part of a process of producing organic chemicals.

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SCIENTIFIC AMERICAN

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NINETY-EIGHTH YEAR — ORSON D. MUNN, Editor

JUNE • 1942

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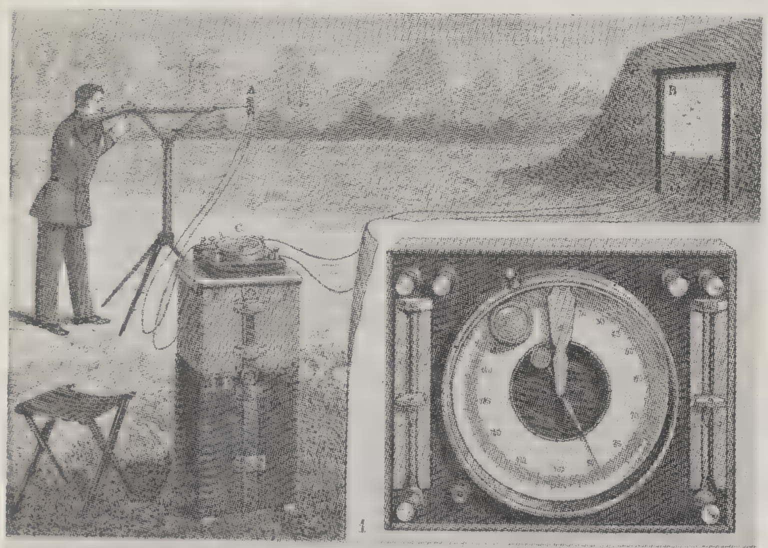
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of June, 1892)

COLOR PHOTOGRAPHY—"The method adopted by Mr. Ives for photographing in colors is another instance of American ingenuity. Acting on Helmholtz's theory that the nerves of the eye respond to wave vibrations corresponding to light of red, green, and bluish violet, and that all tints are made up of combinations of these light waves, he takes three photographs of a scene or object, screening off from the first sensitized plate all but the red rays, from the second all but the green rays, and from the third all but the blue-violet rays. Then he places the photographs on celluloid in a three-lens lantern, and projects these so that they coincide in one picture, screening his lenses with glass of red, green, and blue-violet color. The result is a large photograph in all the actual colors of nature."

CHRONOGRAPH—"The chronograph of Mr. Schmidt, which is capable of measuring as minute a period of time as the ten-thousandth part of a second, is based on this principle: The regularity and rapidity of the movement of the balance wheel of the escapement enables measurement to be made of intervals of time much less than that of one oscillation. . . . These chronographs have been used principally for measuring the initial speed of projectiles. At the moment of discharge the projectile breaks the current by cutting a wire which is stretched in a primary frame attached to the end of the gun. The chronograph continues to operate until the projectile passes through a secondary frame located in front of the target. . . . It is possible, therefore, to read the exact interval that has elapsed while the projectile has passed between the two screens."



APPARATUS FOR MEASURING THE VELOCITY OF PROJECTILES.

ENGINES—"A 60 horse power nominal Otto gas engine is one of the largest gas engines yet constructed. Even when the success of the Otto gas engine of sizes up to 20 indicated horse power had been insured a few years ago, the makers themselves would scarcely have ventured to predict that in the short time that has since elapsed engines indicating 85 horse power with a single cylinder would be commercially successful, and supplanting fairly good steam engines."

MOUNTAIN RAILWAY—"The most recently completed high mountain railway in Switzerland is that up the Rothhorn 7,240 feet high, from the lake and town of Brienz, not far from Interlaken. . . . The material through which the eleven tunnels of this line were excavated consisted of debris which had slipped down the mountain, and which seemed disposed to go on sliding when disturbed. Subterranean springs also made the work difficult, and in places new beds had to be made for mountain streams."

BANANAS—"While apples yield only 12 per cent, bananas with the skins removed yield 25 per cent of thoroughly dessicated fruit. The supply of bananas is practically unlimited. The fruit grows to maturity all the year round, and may be obtained every day throughout the year, so that the manufacture of dried bananas can be made continuous."

MOSQUITOES—"The beak of the mosquito is simply a tool box, wherein the mosquito keeps six miniature surgical instruments in perfect working order. Two of these instruments are exact counterparts of the surgeon's lance, one is a spear with a double-barbed head, the fourth is a needle of exquisite fineness, a saw and a pump going to make up the complement."

CANAL TRAFFIC—"Few persons who have not made a personal study of the matter realize the magnitude of the traffic of the Great Lakes. There were over 1,100 more vessels passing through the canal into Duluth, Minnesota, in 1891, than passed through the Suez Canal the year previous. Through the 'Soo' Canal at the outlet of Lake Superior there were more than three times as many vessels and nearly a million and three-quarters tons more freight in 1890 than through the Suez Canal during the same year."

BOMBING—"Mr. Maxim, of gun fame, has for some years directed his attention to the problem of aerial navigation. Recently he said: 'If I can rise from the coast of France, sail through the air across the Channel, and drop half a ton of nitroglycerine upon an English city, I can revolutionize the world. I believe I can do it if I live long enough. If I die, some one will come after me who will be successful, if I fail. . . . It can be done as sure as fate.' "

FAMINE—"The attention of the whole world is directed to the terrible famine in Russia; consequently it is not generally known that a similar scourge is afflicting India. In this country all the horrors which follow in the wake of starvation occur with fearful regularity every fifteen years, or twice in every generation. The last great famine was in 1876."

SLUMBER—"It is said by scientists to be a fact that all our senses do not slumber simultaneously, but that they fall into a happy state of insensibility one after another. The eyelids take the lead and obscure sight, the sense of taste is the next to lose its susceptibility, then follow smelling, hearing, and touch; the last named being the lightest sleeper and most easily aroused."

PASTEURIZATION—"Machines are in use in Paris and some other cities which will heat great quantities of milk to a temperature of about 155°Fah. for a few minutes, and then cool it rapidly to a low temperature. The method has been called the pasteurization of milk. It does not kill all the bacteria, but it does destroy so many of them that it greatly increases the keeping properties of the milk. Moreover, it almost entirely destroys the danger from disease germs in milk, since nearly all forms likely to occur in milk are killed by this temperature."

X-RAY PHOTOGRAPHS IN A MILLIONTH OF A SECOND

HIGH-SPEED photography, by X-rays, of bullets passing through gun barrels or smashing their way through armor plate are possible with the new X-ray tube invented by Dr. C. M. Slack (left, above), of the Westinghouse Lamp Division laboratories. Dr. Slack is shown explaining a laboratory model of the tube to Dr. Herschel Smith, civilian aide at Frankford Arsenal. At right is L. F. Ehrke, who collaborated with Dr. Slack in the development of the tube. More details of the tube and its uses will be found on page 293.

'POP-GAS' AIDS WAR DRIVE

Harmless Vapor Balks Saboteurs, Saves War Plants

PAUL W. EBERHARDT

SOMEWHERE in New Jersey several hundred men are working day and night turning out steel cylinders, filling them with common ordinary "soda-pop" gas.

Somewhere in Connecticut an airplane engine is taking a final test. A defective fuel line spills raw gasoline on a red-hot steam pipe. Instantly the supply trench under the test cells is a river of flame, but the motor is delivered on schedule.

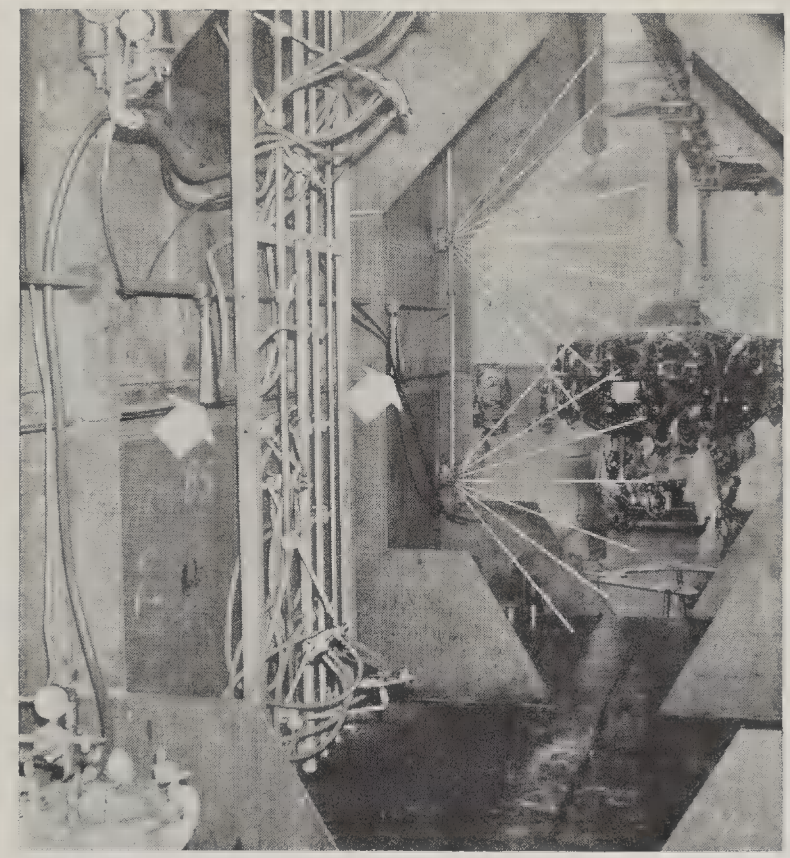
Somewhere in California a saboteur places an incendiary tube in a storeroom stacked with drums of flammable liquids, but the fire department isn't even called. Damage is negligible.

Somewhere in Tennessee a huge generator is supplying thousands of kilowatts of electricity for the manufacture of aluminum. A piece of insulation cracks and flame bursts out, but the faulty insulation is soon replaced and the generator is back on the job.

Somewhere in Alabama a plant is ginning cotton for Army duck. A piece of tramp iron causes a spark, ignites the lint in a flue, but 15 minutes later the gin is back in operation.

From all over the country come reports of fires that threaten great industrial plants, power companies, refineries, and warehouses, fires which threaten total destruction but which are miraculously snuffed out with little or no damage. How do these seeming miracles take place? The answer is in the cylinders being turned out by those men in New Jersey and the "soda-pop" gas with which they are filled. For it is this gas that snuffed the flames at their inception—turned a possible holocaust into just a minor accident.

Legend has it that carbon dioxide's peculiar ability to smother fire was discovered accidentally by a Swedish harbor-master who was using the compressed gas to make a light-buoy wink at regular intervals. One night his supposedly non-extinguishable flame went out, and investigation proved leaking carbon dioxide gas to be the cause. Be that as it may, American engineers get the bulk of the credit for harnessing the gas and teaching it new tricks, for a great many harnessing stunts began on drawing boards in the New Jersey laboratories of Walter Kidde and Company.



Carbon dioxide protects airplane engines under test. Arrows point to discharge nozzles; white lines at right indicate extra gas from special screening nozzles

Carbon dioxide's debut as a fire-extinguisher took place soon after the World War I—on the high seas. The then-untried gas was introduced dramatically to London ship-owners by an engineer, who rented an old trawler, set a raging gasoline fire in its hold, and extinguished the blaze in a matter of seconds with clouds of the cold, white gas. Since that demonstration, carbon dioxide fire protection devices have become standard equipment on merchant vessels. It is even being used on the new Liberty ships which have been stripped of all non-essentials.

Just how does carbon dioxide work on a fire? As any physics student knows, air at sea-level contains 21 percent oxygen. If that oxygen content is substantially reduced, a fire cannot burn. So if enough carbon dioxide is discharged over the flames to cut the oxygen content to 14 or 15 percent, the fire goes out.

This same principle is applied in fighting sea fires. Stored carbon dioxide is discharged into burning cargo compartments, inaccessible to ordinary fire-fighting agents. The white gas penetrates into crevices and underneath bales where fire may be burning, instantly extinguishing all flame. There has been no change in this basic principle since the initial application of the gas to cargo fires. The major improvements have been made in the means of distributing and discharging the gas, and of detecting the fires to be extinguished.

Detecting the presence of cargo fires is as important as extinguishing them, and the old method of having the deck officer sniff at ventilation tubes was

A storage room packed with inflammable materials is protected against fire by a carbon dioxide system. At left, gas is being discharged to cover the whole room as at right. A few seconds later, room was flooded to ceiling

long ago found far too haphazard. The engineers solved this problem by developing an automatic sniffer which employed an electric eye to investigate air samples drawn automatically, every few seconds, day and night, from each cargo hold. These same "sniff pipes" are the pipes through which the blast of carbon dioxide is directed into the cargo hold, once a trace of fire is detected.

But the Kidde engineers did not stop with perfection of this gas for sea-going duties. While one group of engineers worked on the automatic sniffer and similar maritime devices, another group tackled the even larger problem of industrial fire protection. It is to the result of their labors that the airplane engine in Connecticut, the storeroom in California, the generator in Tennessee, and the cotton gin in Alabama all owe their escape from a flaming end.

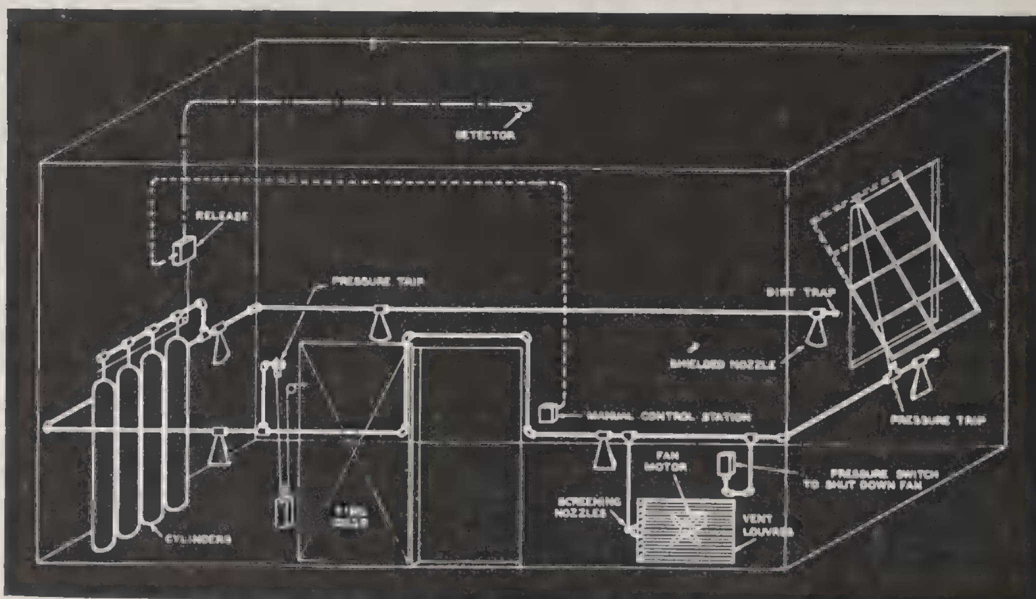
A small cylinder of carbon dioxide supplies buoyancy for life vest

The importance of carbon dioxide industrially comes from the fact that it is especially effective against two types of blaze—Class "B" (flammable liquids) and Class "C" (electrical equipment). For these two hazards account for a large percentage of today's factory fires. What's more, in many of these fires carbon dioxide is the only means of effective control.

For example, let's go back to that test cell in Connecticut and see exactly what happened. As soon as the gasoline ignited, the fire registered on a heat-sensitive detector in the fuel-supply trench. This detector opened the valves of a bank of steel cylinders located outside the threatened area. Carbon dioxide gas, stored in these cylinders at a pressure of 850 pounds per square inch, roared through pipes into the trench, expanding to 450 times its stored volume, and completely flooding the burning space. In a matter of seconds the flames were completely stifled. And after the fire was out, the extinguishing gas dissipated in a few minutes, leaving no residue.

In California, the saboteur had counted on three things—surprise, inaccessibility of the crowded storeroom, and a blaze of such intensity that no human would dare face it. But a carbon dioxide system cannot be taken by surprise. Its heat sensitive detectors were on guard every second of the day and night. Likewise, inaccessibility was no problem, as the system flooded every cubic inch, every niche and crevice of the room, with the heavy, white gas. And of course the human element was not involved, as the whole situation was handled by steel cylinders, steel pipes, and an inert gas which not only flooded the room and put out the fire but, in addition, released trips as it rushed through the pipes, automatically closing doors and windows through which the flames might have spread into other parts of the factory.

The equally important role of gas extinguishing in electrical fires is shown by the generator in Tennessee.



Diagrammatic layout for a typical industrial system for flooding a room with carbon dioxide gas. Pressure trips are used to close doors and windows

As in the previous cases the system was entirely automatic. At the first trace of smoke the generator housing was completely flooded with gas—an action which could be taken without the slightest worry of short circuits and other electrical damage because carbon dioxide is a non-conductor. At the same time, a second bank of cylinders was held in reserve to discharge its contents gradually into the housing and maintain the concentration of gas during the half hour needed to stop the huge rotors. This added precaution did away with any possibility of re-ignition and, since the gas could be dissipated with a few moments ventilation, there was no fear of damage from the extinguishing agent.

The story of the Alabama cotton gin is similar, but it is notable in this case that carbon dioxide does a two-fold job. It not only stifles the immediate blaze, but it is equally efficient in guarding against partially ignited fibers which, if not quenched in the flue, may find their way into the center of a bale and smoulder, later causing a disaster on a dock or aboard ship.

While the above examples are all concerned with automatic systems, some built-in carbon dioxide equipment is operated by manual control. In such cases, however, the control is located at a distance from the fire hazard so that there can be no question of the flames preventing workmen from reaching it.

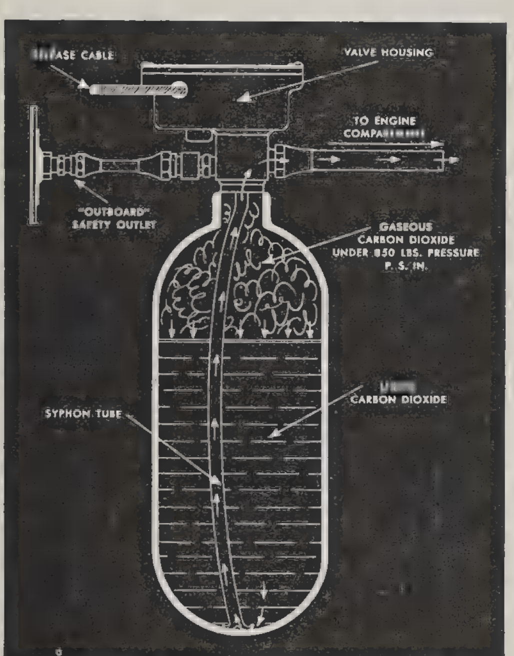


Diagram of extinguisher, hand controlled, for 'plane installation

Still another milestone in the saga of this modern fire-eater was the portable carbon dioxide extinguisher. The impetus to create such a device came first from the telephone companies, who yearned for a fast method of killing switchboard fires—a method which would not saturate or dissolve insulation. The pop-gas filled the bill, but the large steel cylinders then in use for carbon dioxide fixed installations were far too heavy for hand maneuvering. As a result, engineers developed a new light-weight cylinder, which now is not only the basis of the portable extinguishers found in homes and factories throughout the country but, in addition, protects military planes, tanks, and PT boats from fire during action.

But fire-fighting is not the only use to which Kidde engineers have harnessed soda-pop fizz. Among recent developments are collapsible life-belts and life-rafts that can be stored in a small place and given immediate buoyancy by releasing a shot of compressed carbon dioxide. Before the war they even had automatic waterwings for landplanes, which inflated as soon as the plane hit the water and kept it afloat. But these have been discontinued for the duration, lest forced-down ships, floating in war-zone waters, might fall into the hands of the enemy.

• • •

PLANE DETECTOR

Portable, for Use by Plane Spotters

An aural plane detector, easily carried and operated by one man, has been developed by The Zadig Patents, for use by individual spotters of the Aircraft Warning Service. The accessories for the device, including the power supply, are housed in a case smaller than the familiar gas mask container.

When the device is to be used, the spotter puts on a headpiece suggestive of the Buck Rogers fantasies, consisting of earphones topped by a parabolic "concentrator" of sound waves, from which wires are plugged into an amplifying apparatus in the case. When a low-pitched sound in the earphones heralds the approach of a plane, the spotter turns his body until the sound is at its loudest. He is then facing the oncoming plane and is able to turn his binoculars swiftly and accurately on the aircraft to be identified.

It is claimed that the device has been passed upon by technicians of the U. S. Army Signal Corps and by members of the Aircraft Warning Service, who find that it can be used effectively by technically untrained spotters.

The pick-up unit is of thermoplastic material molded to a parabolic curve with a microphone of special characteristics placed at the focal point. The headband which carries the earphones also supports the concentrator.

Microphone in headpiece, vacuum-tube amplifier in case at side

The amplifier and its batteries are contained in a shielded drawer which slides into a compartment at the bottom of the carrying case. The amplifier uses three tubes of the miniature type which are connected in a high-gain circuit. Filters eliminate noises other than those emanating from the approaching plane. A volume control knob regulates the sound in the earphones to the watcher's comfort

BLACKOUT BULBS

Now Emit Deep Orange Light

Important changes in specifications for blackout bulbs recently described in these columns are announced by the Wabash Appliance Corporation, whose silver-lined bulb placed on the market in early January had been put through exhaustive blackout tests in actual city-wide blackouts in many states. Specification changes are based on the results of these tests, as well as on various official recommendations.

The most important specification change is in color of light from blue and red to the deep orange recommended by the office of Civilian Defense. Other changes are in size which is smaller, in reduced current consumption to 15 watts, in elimination of the former built-in reflector, and in an improved type of heavy black silicate coating to prevent light leakage.

The deep orange light that the new unit provides is said to be ample to permit room occupants to see each other plainly, as well as furniture, doors, and windows.

Cement Aids Oil Production

Deep Oil Wells are Controlled and Conserved by Application of High-Speed Cementing Process

ANDREW R. BOONE

THREE compound steam engines mounted on a large truck ceased their laboring. Standing alongside the outfit, Bert Fry wrung a muddy mixture of cement and perspiration from his shirt. A. W. Earl, who had been riding herd on the throbbing engines, closed a pair of control wheels, and Aaron Griffin, trailer tender, moved a horn-like chute to one side.

"Well, boys," Bert grinned, "that does it. Dust fills the hole."

It wasn't really dust, and the hole no longer was a hole. Fry and his crew in 45 minutes had forced 75 tons of fast-setting cement, a special oil-well formula they had mixed with 20,000 gallons of water, down a pipe 11,200 feet long, out the bottom, and up a distance of a mile between the pipe and the rocky wall.

Cement in an oil well performs several important jobs. It prevents water from trickling down into the oil sand from upper formations, protects the casing against collapse due to high pressures in the earth, halts corrosion caused by highly mineralized fluids seeping through the formation, keeps gas from blowing out, and conserves shallow oil formations for future use.

When a drilling crew is ready for cement, they must have it fast, for oil wells have a way of running wild, perhaps bringing in water which ruins their production. It was to meet this need of urgent haste that Earl Halliburton, Los Angeles oil man, devised a system of speedy transportation of large quantities of cement and delivering it in a steady stream to the bottom of the deepest holes in jig time.

Alongside Highway 99, seven miles north of Bakersfield, California, stands one of Halliburton's groups of silos, from which the writer recently accompanied the crew on a cementing job.

This structure, though complicated in appearance, is much like a single silo of the type found on farms. It contains six cement bins, their mouths standing 15 feet up from the ground. Loaded by means of screw conveyors, each contains 55 tons of cement. When a cementing job comes along, a Diesel-engine truck-trailer pulls under the bins, a workman trips a lever, and the stuff pours down through a cloth chute into the huge trailer. When full, a batcher scale automatically weighs the load, and the driver roars off toward the oil field at a 30-mile-an-hour clip.

On arriving at the well, the trailers are backed in a semi-circle against another truck equipped with the three steam-operated pumps. On signal from the tool pusher, four members of the cementing crew swing into action, timing their actions to a split second.

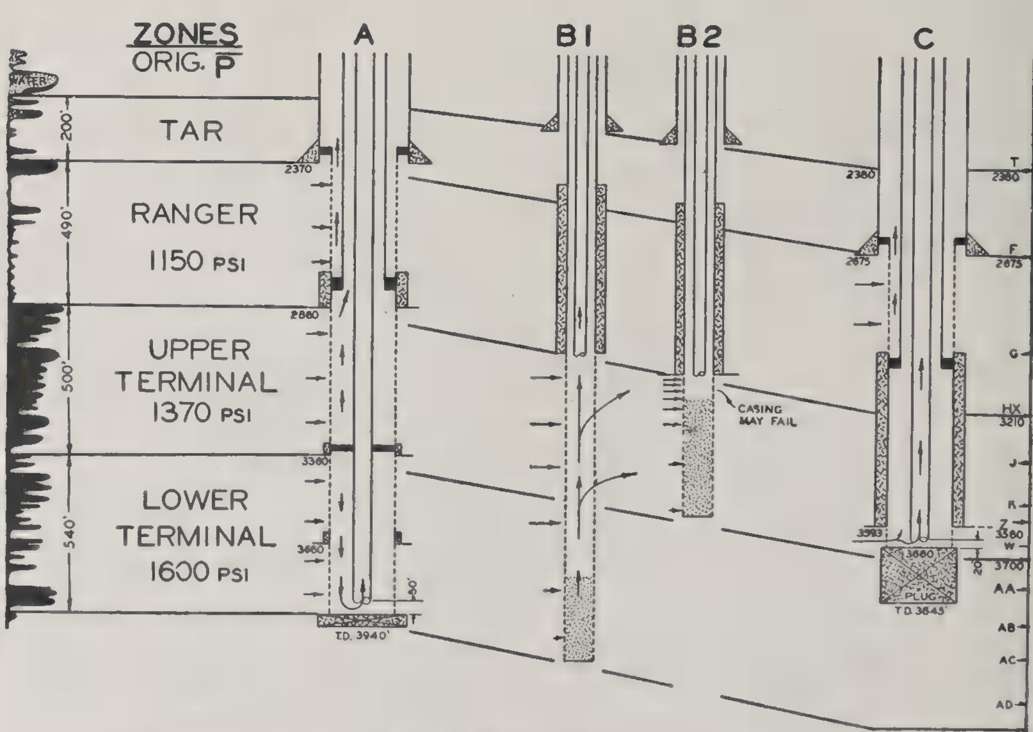
On the front of the first trailer to be unloaded, the driver starts a 16-horse power air-cooled gasoline engine. At the rear, another workman actuates a clutch, engaging the engine with a screw turning at the bottom of a double Vee running the length of the trailer. As the screw begins delivering cement into a cone leading through a small pipe to a slurry box alongside the pumper, still another workman turns on the water. And on the pumper, the fourth man opens a pair of valves, and the pumps start the thin mixture of finely-ground cement and water on its downward journey.

Until recently, a crew of 50 men was required to slit sacks and deliver cement into a mixer. Now four men do the job twice as fast. As the mixture leaves the pumps under pressure of 6500 pounds per square inch, it flows down inside the pipe, forcing ahead and out through the bottom, immediately above the oil sand soon to be brought into production, the mud used to lubricate the drill and pipe. Wood-and-rubber plugs and an expanding basket make it possible to keep mud and cement separated, and to place the cement exactly where it will do the most good. The basket, whose ribs are collapsed as it slides down the hole, lands on top of the oil-bearing sand. There the ribs expand, diverting the cement outward and upward.

MANY oil wells brought into production at great depths would not be flowing today, providing fuel necessary to keep the nation's war machine running, were it not for fast and accurate cementing. Unlike the cement that goes into concrete for pavements and sidewalks, this material is ground so fine that, at a depth of 2000 feet, it will set in an hour; in a 13,000-foot well, under great pressure and at temperatures high enough to produce steam, a hundred tons of the stuff, rising 6000 feet outside the pipe, will set in three hours.

When the heavy plug surrounding the bottom of the pipe hardens, and there is no longer danger of water seeping down from above, the drill is lowered to eat its way once more into the oil. Then, provided the cementers have done their job properly, another oil well is added to the production line.

Cementing also has found a valuable application in the so-called multiple-zone well. This is a well which does the job of two or more individual wells,



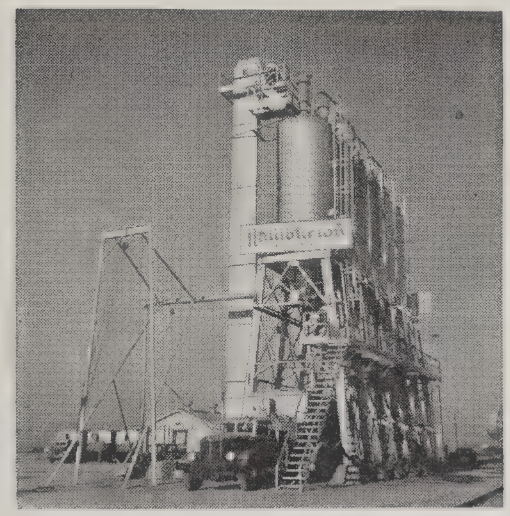
Schematic section of an oil field. See explanation in the text

each drawing from a single zone of oil. Multiple-zone wells have found widest application in the Wilmington, California, field. In this field, the multiple-zone well serves the purpose of permanently separating production of oil at several levels, and controlling each flow individually. Thus oils of various gravities are kept separated, formation pressures conserved, and the flow rates preserved within desired limits.

C. James Dean, field engineer for the General Petroleum Corporation of California, recently reported to a meeting of the American Institute of Mining and Metallurgical Engineers at Los Angeles upon the development of this practice. Accompanying this article is a schematic section, not to scale, of the Wilmington field. It indicates how cement units hold back undesired flows, how two or more zones may be caused to produce through a single well.

At *A* in the drawing is shown a multiple-zone well. Oil from the Ranger zone flows between the casing and a blank flow string; from the Upper Terminal zone between the casing and tubing; and from the Lower Terminal through the tubing. Packers inside the casing and cement outside separate the various zones.

"A multiple zone well," explains Mr. Dean, "when properly completed prevents the migration of oil and gas from high-pressure zones to zones of lower pressures. *B1* and *B2* in the drawing illustrate an example of migration believed to exist in wells with long un-



Cement in this battery of silos can be loaded in trailers at a rate of 100 tons in half an hour

broken producing intervals. A Full Terminal well producing at a curtailed flow rate is permitting gas and oil from the Lower Terminal Zone to repressure and resaturate a neighboring Upper Terminal well which is producing at the same daily rate from a thinner zone of lesser pressure. This involves not only the monetary value of the gas and oil lost, but, in addition, the limited gas energy is being used to actually drive oil away from the higher pressure well, leaving comparatively dead oil in the Lower Terminal Zone,

The fine cement is fed by screws to a cone, from which it is drawn to the slurry box for water mixing

to be recovered by less efficient mechanical methods. This migration could have been prevented by multiple-zone practice and probably still can be abated by producing the Full Terminal well through tubing hung near the bottom of the hole . . . . .

"It is significant, too, that the segregation of the zones permits taking the restricted allowable quantity from the zone producing the most desirable oil. The ability to regulate the pressure differentials which cause flow to the well is useful in the control of entrance velocity rates which determine the ability of the entering fluid to carry sand. This permits the production of the maximum sand-free rate from each zone."

Where may this technique be applied?

"The drilling of multiple zone wells," says Mr. Dean, "is in general a satisfactory practice on leases with insufficient drilling sites for the individual exploitation of several zones, and as a counter measure to offset wells which are either multiple zone or very densely spaced. Another accepted application would be for the development of sands or zones which in themselves do not justify the drilling of individual wells.

"The principal problem in the casing and cementing of a multiple zone well lies in the proper placement of a sufficient quantity of uncontaminated cement behind sometimes very short intervals of blank pipe. Oil zones at locations which offer no intermediate water problems are not difficult to separate with very small quantities of cement. Annular spaces requiring as little as 15 sacks have been filled effectively to separate zones. The necessity for simultaneously effecting a zonal separation and water shut-offs at the top and bottom of the blank interval is a more difficult problem. To do this the pumping of an excess of cement is desirable, which in turn involves the problem of the removal of the excess without cementing off perforations."

How may this feat be accomplished? Mr. Dean continues, describing one successful method:

"The casing is run with properly spaced sections of perforated and blank pipe. At the bases of the blank sections are placed upright cement baskets with the usual cementing parts. At the top of the blank sections are inverted baskets with open ports to receive the excess cement. The inverted baskets are wired to prevent expansion until in place. At the basket for the lowest cement job there is a duplex cementing collar which consists of a solid bottom baffle below the ports and a back-pressure valve above the ports. Tubing is then screwed into, or is sealed off on, the duplex collar and the cement is pumped into place. After displacing the

From the slurry box, where the cement-water combination is shown being checked, the mixture is forced into the well by pumps

cement, the tubing is raised to the top of the blank section and the excess cement in the casing is circulated out. The procedure at any of the cement points above the lowest is as follows: a cement retainer is set as a bridging plug below the ports, tubing is run and packed off above the ports with a second cement retainer; the cement is then pumped into place and the excess removed as described before.

"This method provides a positive means of placing the cement and prevents any movement after placement due to unequalized columns or circulating pressures. The drilling up of several retainers in the casing is troublesome, but not hazardous."

Rotating Galaxies

That the Spiral Nebulae Rotate is Now Beyond a Doubt. Our Own is Not Much Larger than Others

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University; Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

THE great spiral nebulae are flat, thin disks—as is proved by the fact that we see some of them edgewise. There is no reasonable explanation for such a shape unless they are rotating. We now know that they are so far away that even very rapid motions would not shift the finest details on our photographs by a perceptible amount except after many centuries. The spectroscope, which measures velocities of approach or recession independent of distance, is our only hope; but observations are difficult, for the surface brightness of these objects is very low, and spectrographs of special design are necessary to concentrate enough light onto the plate to produce an image. Nevertheless, Slipher, in 1914, proved that the great Andromeda nebula was rotating, and Pease, in 1917 (with an exposure of 79 hours!), followed the motion through a region five minutes in apparent, and 1000 light-years in actual, diameter. Within this region the velocity increases steadily with the distance from the center, attaining about 75 kilometers per second at 500 light-years from the center, so that this part of the nebula is rotating almost uniformly at the rate of one revolution in 11,000,000 years.

This is, however, only 5 percent of the distance to the outer portions of the spiral arms, which were then too faint to observe. Twenty years' improvement in spectroscopic design made it possible for Horace Babcock (son of the well-known solar observer), working at Lick in 1938, to carry his measures more than ten times as far—to a distance of 30 minutes, or nearly 6000 light-years, from the center, with exposures running up to 21 hours.

Beyond this the star-clouds are too faint to be observed. But there are several small patches of emission nebulosity—gaseous nebulae belonging to the Andromeda system, as the Orion nebula belongs to the Galaxy—which have bright-line spectra and can be more easily observed. One of these, nearly on the long axis of the nebula, is 96 minutes from the center, corresponding to the enormous distance of 18,000 light-years.

The velocities measured from these spectra showed that, at a distance of about 800 light-years from the center, the rotational velocity reached a maximum, dropped to small values at 1600 light-years, and then increased again, until for the most distant emission patch it rose to 370 kilometers per second, giving a rotation period of 100,000,000 years.

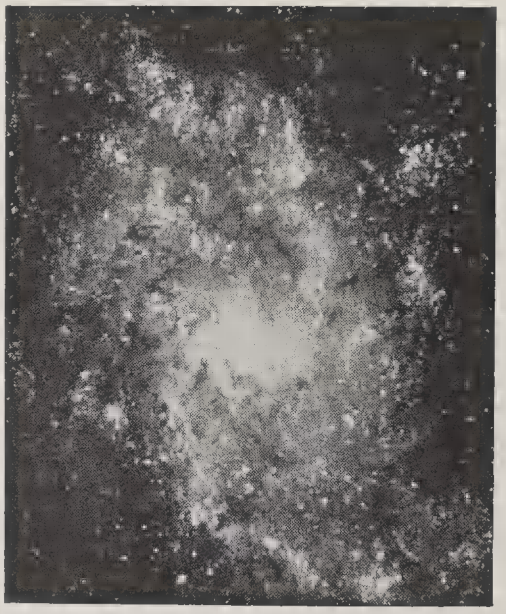


Photo Mt. Wilson Observatory

The magnificent spiral nebula M 33

The only other nebula large enough to be available for a similar detailed study is the magnificent resolved spiral Messier 33 (No. 33 in Messier's Catalogue). This is so faint that the motion of the star-clouds can be studied only close to the nucleus; but there are many patches of emission nebulosity, and no less than 20 of these have been observed by Mayall and Aller at the Lick Observatory. Their results, just published, show that all these objects on the south-west side of the nucleus (as seen in the sky) are receding from us, compared with the nucleus, while all but one on the north-east side are approaching, and place the rotation beyond doubt.

The general form of the nebula indicates that its plane is inclined 33 degrees to our line of sight. Allowing for this (as was, of course, also done for the inclination of 15 degrees for the Andromeda nebula) and adopting Hubble's distance of 700,000 light-years, it is found that the rotational velocities of the condensations increase to a maximum of 120 kilometers per second at 3500 light-years distance from the center, and fall off gradually to 60 kilometers at 600 light-years. The corresponding periods of revolution are about 50,000,000 years at the smaller distance, and 190,000,000 at the larger.

Hubble, reporting briefly on work by Humason and himself, records periods ranging from 3,000,000 years for an elliptical nebula, without spiral arms, to 200,000,000 for the outer parts of fully resolved spirals.

Both in the Andromeda nebula and in Messier 33, the regions along the apparent minor axis of the general elliptical outline show substantially the same motion as the central nucleus. This completes the evidence that the motion is really rotatory, for, at such point, rotation would carry the material of the nebula at right angles to our line of vision, without change of distance. In both cases the nebulae as a whole are approaching us—or, more reasonably put, the Sun is approaching them. This motion, shared by the stars in general in the Sun's vicinity, is itself due to the rotation of the Galaxy, which carries part of it where we happen to be toward these nebulae.

THESE vast motions of rotations demand explanation—not the mere fact of rapid motion, which is no more remarkable than what we call rest (relative to ourselves!), but the fact that the motion is curved, in paths which, on the average, are evidently nearly circular about the nucleus of each nebula. To draw any moving body into a curved path demands attraction—in this case an attraction directed toward the center. The only known force capable of producing such an influence on such a scale is gravitation. The combined attraction of the countless millions of stars which compose the nebula will average out to draw bodies in the direction of the center. The dark matter, which reveals its presence in the form of obscuring clouds, will add to the effect, if there is enough of it.

Knowing the radius of the circle described by any point, and the period, the inward force can very easily be calculated. For both nebulae, in the inner region where the rotation period is nearly constant, this force *increases* with distance from the center. If the whole mass, or at least most of it, were

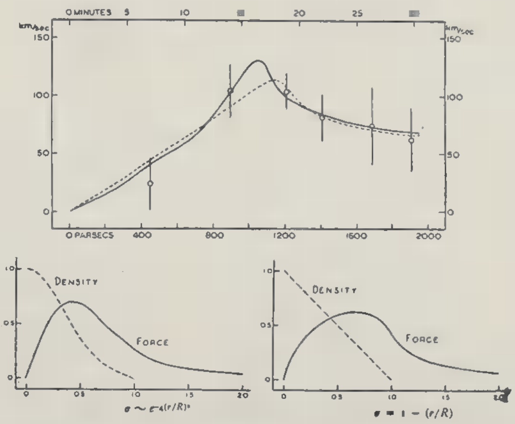
concentrated in the nucleus, this would not happen, but, as in the solar system, the orbital velocity would decrease at greater distances. The larger velocity there shows that the attraction of a greater quantity of matter is effective. This would happen inside a uniform spherical cluster of stars. It was shown by Newton that the combined attraction of all the stars nearer the center than the attracted body is the same as if they were lumped at the center, while the stars farther out than this point attract in all directions, in such a way that the net forces in all directions balance, and no effect is produced. As one goes farther from the center, a greater part of the whole mass becomes effective, and the attraction increases.

The nebulae, however, are anything but spherical and it is certainly a much better approximation to regard them as thin disks. In this case the effect is exaggerated. The parts of the disk nearer the center attract with their full force (though not exactly as if concentrated at the center); but the near side of the outer ring now has a greater attraction than the far side, so that its net attraction is outward, diminishing the total force. Outside the boundary of the disk the attraction falls off rapidly.

The expression for the attraction of such a disk is complicated, especially if it is assumed (as is reasonable) that its density is different at different distances from the center. Wyse and Mayall have just published a paper (with nine or ten pages of formulas full of elliptic integrals), have computed tables which can be used for calculation, and have applied these to the two nebulae whose rotations have been observed.

For Messier 33, the situation is fairly simple. Two assumptions regarding the density give a good representation of the facts. In the first, the disk is supposed to get thinner (or less dense) toward the edge, like a very greatly flattened ellipsoid of rotation. The outer radius is 3900 light-years. The second gives a nearly constant density up to 3000 light-years, dropping rapidly to zero at 3500. The observed and calculated rotational velocities are shown in the upper part of the drawing. Both curves fit the observations satisfactorily—the solid representing nearly constant density, the other varying density.

For the Andromeda nebula, where the velocity falls off and increases again, a more complicated model was required, consisting of a small and relatively dense disk of radius 850 light-years, at the center of one of lower density, at first increasing outward, and of radius 19,500 light-years. This curious distribution of density (shown at lower left in drawing) accounts for the still stranger distribution of velocity—according to Babcock's observations—shown at lower right. The very small force, indicated by the slow rotation at 1600 light-years (500 parsecs), arises



Courtesy *The Astrophysical Journal*

Calculated rotational velocity-curves for M 33. Solid line: nearly constant density. Dashed line: density varying according to thickness of an oblate spheroid. The circles and vertical lines represent observations with their probable errors. Lower curves are examples illustrating the relation between density distribution and central gravitational force. Abscissae (horizontal) are distances from the center with the radius of the disk as a unit. Ordinates (vertical) are arbitrary units, which are mutually consistent for the density and the force. From the published paper by Wyse and Mayall

because this region is well outside the inner disk, so that its inward attraction is much diminished, and inside the region of greatest density of the outer disk, so that its net attraction is outward, and decreases the total force.

Even this remarkable distribution of velocities may therefore be explained by the gravitational attraction of a quite reasonable distribution of matter.

The masses of the nebulae, resulting from these calculations, are very great. For Messier 33 the two solutions give masses 1,600,000,000 and 1,800,000,000 times the Sun's mass. For the Andromeda nebula, the mass of the small central disk comes out equal to 560,000,000 Suns, while the huge outer region totals 95,000,000,000 times the Sun's mass.

The two systems appear, therefore, to be very different; but it has long been recognized that Messier 33 is not far from being an average spiral nebula, while the Andromeda nebula is in all respects a giant. Our Galaxy is probably even bigger—the Sun is some 30,000 light-years from the center—and there are plenty of stars still visible on the opposite side of the Milky Way, farther out. Calculation of the galactic rotation makes the period at the Sun's distance about 200,000,000 years, and the total mass between 100,000,000,000 and 200,000,000,000 Suns. No system greater than the Galaxy has yet been discovered; yet it does not appear to differ very much from the largest of the others. Shapley's suggestion—well expressing the uncertainty of a dozen years ago—"Perhaps the nebulae are island universes, but the Galaxy is a continent"—would hardly be made now.

The new measures emphasize one strange property of these nebulae, already indicated by earlier observations. A large part of the light of both systems is concentrated into small regions close to the nucleus; but nothing of the sort happens with the mass. The faint outer parts of the Andromeda nebula, which are invisible to the eye, and are revealed only by long-exposure photographs, contain an amount of mass, per square light-year of cross-section, about one tenth that of the central region, but, for equal areas, they send us less than a thousandth part as much light. If both were composed of stars of the same kind—or the same mixture of stars of different kinds—and differed only in the number of stars per thousand cubic light-years, the ratio of mass to light would obviously be the same. There must therefore be an enormous difference in the distribution of the various forms of matter in the two regions. If the central regions were composed mainly of stars of large mass, and high luminosity, and the outer parts of faint dwarf stars, some such difference might occur. But the outer regions are resolvable into stars, which must be very bright to be observable individually even with the greatest telescopes, and such objects are not found near the nucleus, though they should still be observable there. It is hard to escape the conclusion that, in the outer regions, there are great quantities of dark matter, of aggregate mass much exceeding that of the visible stars.

This ties in well with Whipple's conclusion—which we reported last month—that it is in just such regions that giant stars may still be born. We must wait, however, for further data before these questions can be settled, and observation of even the nearest nebulae beside the two already studied will be "an observational problem of the first magnitude"—so Mayall and Aller say—and they know about it from experience. — *Mount Wilson Observatory, March 24, 1942.*

Rubber Facts That Don't Stretch

A Systematic Survey of Minor Emergency Sources of Natural Rubber in the United States

An outstanding American trait is a penchant for self-deception through wishful-thinking—often rationalized as optimism. Such optimism can, however, be a vice. For example, readers will recall numerous glowing articles in magazines and newspapers during the past decade in which the great expectations from some newly-found and marvelous wild rubber-giving plant or weed were extolled. Yet, somehow, nothing came of these hopes. Now that we need rubber, where are these wonderful weeds? Some of us, it appears, still hope they will jump into the breech and save us. Guayule, of course, is satisfactory, but never was one of the wonderful weeds; it long ago proved up well. But what of goldenrod, rabbit brush, Russian dandelion, and others? Aren't at least some of these *it?* Believing our readers would prefer the truth to optimistic observations, we asked the United States Department of Agriculture for a canvas of the emergency sources of natural rubber in the United States, free from wishful thinking. The accompanying data are what we received. — The Editor

THERE are thousands of species of trees, shrubs, vines, and smaller herbaceous plants that contain rubber, many of which are native to the United States or are known to grow under our conditions, though only a small proportion of the eligible species has been tested. Some are tropical or subtropical plants that probably would have to be confined to southern Florida, while others are native to or could be grown in dry regions like the southwestern states.

Cryptostegia: Two species of Madagascar rubber vines, *Cryptostegia grandiflora* and *Cryptostegia Madagascariensis*, have been planted in many localities in Florida as ornamentals because of their handsome foliage and flowers. The first species is a large climber, while the second takes the form of a broad, rounded bush five or six feet high. A hybrid of the species also has been propagated and studied in Florida. Rubber obtained from *Cryptostegia* has been tested and found to be of good quality but the present supplies of these plants are limited. The percentage of rubber in the roots, stems, and leaves is very low, running only two to three percent, and the cost of extraction of the rubber is high.

Ornamental plants in Florida might yield small quantities of rubber but, for immediate emergency use, propagation or reproduction would be slow and no appreciable tonnage could be expected from this source within the next several years. This is a plant that could be handled by machinery equipped for extracting rubber from guayule but, because of the low rubber content, the extraction is inefficient and costly. Considering the low yield, the time required for production in volume, the difficulties of extracting, and the low percentage of rubber, *Cryptostegia* is not regarded as a practicable source of rubber in this emergency.

Milkweeds: Experiments also have been made with native rubber-bearing plants of the hot desert districts of southern California and Arizona. A promising species is one of the desert milkweeds *(Asclepias subulata)*, with tapering, slender stems growing in clumps like a large bunch grass. A second desert milkweed, *A. erosa*, also has been tested and found to contain even higher amounts of rubber than *A. subulata*. Methods of cultivating these plants have been worked out, and they could be grown in large quantities in the desert districts. In cultivation tests, the yields of rubber have been so low that it has never been possible to demonstrate more than 80 to 90 pounds of rubber per acre per year from either of these species. Processes of extracting the rubber and utilizing it commercially have not been developed.

In addition to these two species of milkweed, attention has been given to the common broadleaf milkweed, *A. aspira*, common to the eastern states, but it has proved less promising than either of the two desert milkweeds. Another plant, commonly known as California milkweed but belonging to the composite family rather than to the true milkweed family, is *Stephanomeria virgata*. In spite of publicity recently given this plant, it has been impossible to demonstrate that it contains an appreciable amount of rubber. At the present time, no member of the milkweed group could be considered promising in comparison with the tested quality of guayule rubber.

Euphorbias: This group contains innumerable species of latex-bearing plants closely related to the true Para rubber tree. However, only one of these has ever been an important source of crude rubber. This is *Euphorbia intisy*, native to Madagascar, which was introduced into the United States in 1928. Cultivation experiments with this plant in the United States have been disappointing. It has been impossible to obtain seeds, and reproduction by cuttings has been very slow. It takes a period of many years to grow the plant and the plant must be destroyed to obtain rubber. The common Christmas plant, *Poinsettia*, also is a member of this group and has been promoted and tested for rubber production. Reliable tests have demonstrated that the rubber content of this plant

Rabbit brush, New Mexico. Enormous labor for only 40,000 tons

is too low for serious consideration.

Russian Rubber Plants of Anterior and Middle Asia: A number of plants have been discovered and tested in Russia for rubber production. Reports are that several of these have been cultivated on a fairly large scale. Of late, publicity has been devoted largely to the *kok-sagyz,* which is a species of *Taraxacum,* or dandelion.

The current favorable reports on performance of these plants do not appear to be verified by records of actual field performance in Russia received from reliable sources. In contrast to the reported rubber content in the roots of 10 to 27 percent, recent information from Russia indicates that when grown on a large scale by collective farms, the maximum percent rubber is 3 to 5 percent, and the average 1 to 1.5 percent. From the same source, it also appears that the average yield of the *kok-sagyz* root per acre is about one-half ton. On the basis of the maximum rubber content, that would be only 50 pounds of rubber per acre, which is pitifully small. Other plants tested by the Russians are the so-called *tau-sagyz,* which is a species of *Scorzonera,* related to black salsify, and the *krim-sagyz,* also related to the dandelion. Results in Russia are less favorable than those from *kok-sagyz.*

Goldenrod: The late Thomas A. Edison discovered that of some thousands of species native to the United States, which he tested for rubber, the goldenrod showed the most promise in so far as rubber content was concerned. Cultivation experiments were initiated by Mr. Edison and later continued by the Department of Agriculture. Selections with improved yield of rubber were obtained but, up to the present, it has not been possible to produce the rubber in a quality acceptable on the American market. The rubber heretofore produced, on being tested at the National Bureau of Standards, showed a tensile strength of approximately 50 percent of that of comparable compounds using Para rubber and a resistance to abrasion of only 35 percent of that of Para rubber.

In addition, satisfactory methods of extracting the rubber have not been devised, so that the cost of the present method of extraction by chemical solvents is very high and inefficient. For certain uses, rubber from goldenrod is acceptable despite the impurities, but it does not lend itself to large-scale substitution for Hevea rubber. Only a small amount of propagated material of improved strains of goldenrod is available at the present time and a maximum planting of 60 acres in 1942 would be possible, followed by a 20-fold increase in 1943. The use of unselected goldenrod is quite out of the question because of low percentage of rubber and small leaf yield.

Goldenrod. Much talk, but its use is out of the question

Rabbit brush: Many portions of the states of California, Arizona, Nevada, New Mexico, and Utah grow a species of *Chrysothamus,* known commonly as rabbit brush. This plant contains appreciable amounts of rubber, running up as high as 6 percent of the dry plant content. Results in survey publications of 1919 indicate that appreciable quantities of rubber could be obtained from these wild plants. In many places, the rabbit brush occurs in almost pure stands but such stands are limited to local areas, widely scattered over these six states. The work of collecting and transporting is possible, but would be very arduous and would make large demands upon man-hours of labor.

The rubber has been extracted from rabbit brush by the method used for extracting rubber from guayule, and the rubber has been tested and found to be of good quality. The rubber extraction plant in existence at Salinas, California, could be utilized without modification for extracting rubber from rabbit brush, particularly from areas in the Mojave Desert and contiguous portions of California where some of the best stands have been located. It is estimated that as much as 30,000 to 40,000 tons of rubber may be obtained from plants of this species actually growing, but at enormous labor cost.

Osage Orange: Because of its milky juice, osage orange or hedge apple, botanically known as *Maclura pomifera,* has attracted attention as a possible source of rubber. Interest in this plant dates back to before 1910 and studies have been conducted by many investigators. Tests conducted in the laboratories of the Department of Agriculture have failed to show even 1 percent rubber in the fruits of osage orange and analyses of other parts of the plant have been equally disappointing.

Microörganisms: Synthesis of rubber by the use of bacteria or other microörganisms has been suggested as a possibility. The idea is to inoculate expressed juice of rubber-bearing plants and increase the amount of rubber yield from a given weight of the plants. As the rubber-bearing plant, itself, synthesizes rubber, there is no reason to doubt the possibility, providing the necessary elements or materials are in the expressed juice, or in the air and available to the microörganisms, but successful use of such methods to produce rubber have not been demonstrated.

From The Ground Up

Our Chemical Industry Had the War-Time Advantage of Starting Practically from Scratch

DOUGLAS M. CONSIDINE
Chemical Engineer

The production of explosives and munitions constitutes a very minor part of the great American chemical industry in peacetime. Even in times of war, munitions production does not completely overshadow production of other chemicals and chemical commodities commonly identified with peacetime usage. Thus the chemical industry, today, is playing a most important and dual role in our war preparations; namely, by producing explosives and materials commonly identified with war, and by expanding production of such essential peacetime commodities as petroleum, rubber, and plastics. Of great significance is the fact that petroleum refining and rubber and plastics production are as dependent upon chemical technology as is the actual production of explosives.

In the fall of 1940, when an initial sum of $75,000,000 was made available to the War Department for construction of munitions plants, the stage was set for possibly the greatest task ever to be undertaken by the chemical industry of any nation. That long list of military ingredients, which has since become so trite, was placed on order for delivery as soon as possible. But nearly all the plants for this production were still on paper, or yet to be designed. We did not have any Krupps or Schneiders; we had neither a Skoda Works, nor a Vickers Armstrong, Limited. In a European sense, we had no munitions industry! Our peacetime facilities could supply no more than 10 percent of requirements and these plants were already on a 24-hour basis making munitions for Britain.

America's disadvantage in having to start from the ground up was not without assets, the greatest of which proved to be our ability to locate these plants according to all the best lessons of economic geography. Several factors were considered before the plant sites were selected. Despite the huge sizes and great capacities involved, expansion for the future had to be considered. Incidentally, this early foresight has proved a boon to expediently carrying out America's second great munitions program. As remote as an air attack on American soil seemed in 1940, the possibility of long-range bombing operations had to be considered. A strip 200 to 250 miles deep from the geographical boundaries of the United States was ruled out. New munitions plant construction was to be reduced to a minimum in this limited zone. World War I munitions production was confined chiefly to a geographical triangle, of which Boston, Pittsburgh, and Wilmington were the vertices. This resulted in critical power and transportation problems. Our great World War II industrial load had to be distributed as evenly as possible throughout the nation. In addition, availability of labor and raw materials, usually the primary guides in peacetime plant location, had to be weighed on the plant location balance. Good transportation facilities and power in large quantities had to be available to this great new industry. Coal and water had to exist nearby in great abundance.

Selection of sites in Illinois, Indiana, Virginia, and Iowa seemed a bit surprising until the War Department's fundamental policy became more evident. These plants were being located where there were vast undeveloped reserves of labor and natural resources. A new geographical network was being laid. As a result, the new munitions plants are drawing most of their workmen and supplies from neighboring vicinities, tending to eliminate the sacrifice and strife involved when labor migrates to cities and industrial centers already overcrowded. The difficulties which some communities have suffered to date from this cause are insignificant, as compared with the situations which would have been precipitated had this factor not been in the foreground when plans were being made.

This forethought will greatly aid the industrial situation when the present emergency has passed and these plants are put on bank. In the meantime, we may expect these plants to grow into centers for important peacetime industries. Munitions plants are chemical plants and the chemical industry is turning more and more to farm products as a source of raw material. With the equipment on hand to conduct the unit operations of chemical engineering, so-called "Chemurgy" may find a boon in these newly created industrial areas, tending to unite the chemical industry and agriculture into one great beneficial combine. When one realizes that all these factors and many more had to be seriously considered, the War Department may not only be excused, but lauded for using good farmland for the location of plants devoted to the manufacture of munitions and to other wartime activities.

One of the nation's largest combined shell loading and TNT plants rapidly took form in a mid-western state. Over 280 farms, comprising 38,000 acres of fertile farmland were converted into a great arsenal occupying some 35 square miles. Adjoining this Ordnance Works is a great shell loading works with an area of 22 square miles. Cost of the Ordnance Works was approximately $48,760,000 as compared with a cost of $22,000,000 for the shell loading plant. An expansion of these plants at an expansion of these plants at an expenditure of $9,400,000 has already begun. The Ordnance Works includes some 450 buildings and is surrounded by over 40 miles of unsurmountable fence. The shell loading plant includes some 500 buildings, several of which are powder and ammunition magazines.

The principal raw materials for the preparation of TNT are toluol, sulfuric acid, and anhydrous ammonia. Toluol will be shipped to the Ordnance Works from a plant in Texas and from by-product coke ovens in the Chicago area; sulfuric acid will come from Chicago plants; ammonia will be shipped in tank cars from plants in West Virginia and Kentucky.

Loading and assembling shells will be the primary function of the shell loading plant. Empty shells and cartridges will come to the loading plant from scattered midwestern factories. High explosives for shells will come primarily from the neighboring Ordnance Works, while smokeless powder will come in bags from an Ordnance Works nearby. Facilities at the shell loading plant for loading airplane bombs, artillery shells, and fixed round ammunition will center about three loading or manufacturing lines. Of industrial interest is a conveyor line costing approximately $500,000 which carries shells through the long loading lines.

A small village in a nearby state

has been transformed into a thriving community and the site of America's largest smokeless powder plant. Over 20,000 people were engaged in $75,000,000 worth of construction to erect this plant. The plant site covers an area of thousands of acres; over 50 miles of standard gage railway track and 25 miles of narrow-gage track are required to serve some 650 buildings. Over 20 miles of water main are required to carry water to satisfy this plant's enormous requirements.

THIS plant exemplifies the great care exercised by the War Department in locating munitions plants. Located inland, it is practically immune from all but longest range aerial bombers. This plant is able to draw on the large industrial populations of nearby cities. A river provides an unlimited supply of water and a convenient means for diluting waste products. Transportation facilities, both rail and highway, are excellent.

The story of this plant is an epic in the history of great American chemical and powder plants, but only typical of the great series of similar plants now completed or under way. Construction of the plant started on Sept. 3, 1940, and proceeded with great rapidity. Soon after that date, modern ditching machines were digging foundations. A concrete plant, with a 2000 cubic-yard-per-day capacity was installed. Roads and railroad trackage suitable to construction purposes were rushed to completion. Steam required at the various parts of the huge plant site could not be purchased locally. This problem was expediently solved by renting four large railroad locomotives which served as mobile units, supplying steam requirements wherever needed. Twenty thousand board feet of lumber required were supplied by a saw mill built right on the grounds. Notwithstanding the immensity of this undertaking and the role that time played, confusion was reduced to a minimum and an All-American construction safety record of 4,000,000 man-hours without a single lost-time accident was established.

Ammonia, cotton linters, sulfuric acid, and alcohol are included in the list of important raw materials required for smokeless powder production. Ammonia will come to the Ordnance Works from a plant in Kentucky; cotton linters will be brought up the river from the south; great sulfuric acid plants in Tennessee will supply this vital ingredient; alcohol will come from nearby midwestern plants.

The first of Uncle Sam's new ordnance plants to begin production was in Virginia. Construction of this $40,000,000 plant was started late in 1940 and required the employment of some 22,000 workers. Production of smokeless powder began just five months later. A few miles away was constructed another Ordnance Works, a $10,000,000 plant which will load part of the smokeless powder produced at the first plant into bags for use in large caliber guns. The third of three smokeless powder plants scheduled on the War Department's first program is under construction at a cost of $48,000,000. The second program calls for a $60,000,000 smokeless powder plant.

Other arms, ammunition, and explosive plants on the first program, now under construction or in operation, include a shell loading plant—cost $17,000,000; a TNT-DNT plant—cost $11,000,000; a TNT-DNT plant — cost $9,388,000; and small-arms munition plants at costs of up to $30,419,000. The first program also called for two $1,000,000 plants for the production of activated carbon.

EXPANSION of the first program calls for additions to practically all of these plants at costs, in most cases, in excess of the original investments. Included in the outstanding new plants of the second program are a $26,000,000 TNT-DNT-Tetryl plant and a $33,500,000 ammunition loading plant. Even this by no means completes the lists of plants now proposed or under construction.

Despite the fact that we had practically no munitions industry in 1940, our chemical preparedness was considerably better than the period of World War I. In many cases, our 1940 peacetime production of strategic raw materials used in munitions manufacture was considerably greater than the peak of World War I production in 1918. For example, in 1918, we were producing 75,000 tons of ammonia per year. Today, our synthetic ammonia production alone totals several times this figure. But even with this great production, plus ammonia obtained from other sources, our present ammonia production, which momentarily appeared bright, is, in reality, only about one half of estimated requirements; chlorine production is in somewhat the same status.

As stated previously, our production of munitions in 1940 was sorely lacking, from a war-time viewpoint. In 1918, we were producing 192,000,000 tons of TNT per year, while in 1940 production was only 10,000,000 tons; early defense needs for this high explosive were estimated at 600,000,000 tons. In 1940, we had practically no commercial production of picric acid, as compared with the 1918 production of 140,000,000 tons. Smokeless powder production in 1918 amounted to 513,000,000 tons, as compared with our 1940 production of 30,000,000 tons and a total estimated requirement of 900,000,000 tons.

THE comparative abundance of some war-time raw materials and lack of others may be explained primarily by the fact that many materials, essentially concerned with war-time usage in 1918, now have found their peacetime counterparts. Many others have not. Thus, we find ammonia used in hundreds of chemical processes for the manufacture of peacetime goods, while a peacetime place for picric acid has not been found.

Toluol is the basic raw material for TNT. Large amounts of TNT are used in airplane bombs which carry up to 60 percent of their weight in TNT. This is a lot of TNT in bombs weighing a ton or more each! Artillery projectiles carry 15 to 20 percent of their weight in TNT. Before World War I, our primary source of toluol was the by-product coke oven, with a capacity of about 100,000 gallons per month. This production was stepped up to 800,000 gallons by April 1917. An expenditure of $30,000,000 provided additional coke oven capacity in plants of eight large steel companies and new ovens at five other mills had been contracted for at the time of the Armistice. But toluol from coke ovens was not enough! In November 1917, construction was started on plants for stripping toluol from domestic heating and illuminating gas. The first plant of this type, a $7,500,000 project, went into production in April 1918 and, throughout the duration of the war, 13 large cities used gas with 6 percent less heating value.

Finally, a third source of toluol—petroleum—was tapped. Toluol was produced at a monthly rate of 400,000 gallons in several California refineries and all doubts of adequate toluol supplies were erased. This represents the mad scramble for toluol during World War I and it must be remembered that toluol is only *one* raw material used in munitions production. This scramble proved successful. Our Army's requirements were filled, 11,000,000 pounds were shipped to the Allies, and 17,000,000 pounds were left over at the time of the Armistice.

Today, our toluol problem is large, but vastly different from that of World War I. The solutions are more obvious and easier. The important questions, today, are those relating to minimum costs and maximum industrial convenience. Great strides in research and experience in the present conflict have

placed the petroleum industry in an effective position to fill the gap in toluol production. The coke oven remains our primary source of this strategic raw material, however. Better equipment and methods now make it possible to obtain from 20 to 25 percent more toluol per ton of coal coked than was obtainable by the methods of 1917.

Our nitrogen needs are being bolstered by the construction of several new ammonia plants. Nitrogen is an important ingredient of nearly all explosives. It is estimated that ammonia production from privately-owned plants will reach over 1000 tons per day. One government-financed plant of 450 tons per day capacity is being constructed in West Virginia; several government-financed plants of 250 tons per day capacity each are scheduled for construction in Kentucky, Alabama, Louisiana, Missouri, Kansas, Arkansas, and Ohio. We must be concerned with one fact; from 18 months to two years are required to construct a synthetic ammonia plant, as compared with other munitions plants which can be built in eight or nine months.

Sulfuric acid is vital to munitions production and, today, is made principally from raw elementary sulfur, or brimstone. Today, our sulfur resources and facilities for producing sulfuric acid are among the brighter spots in the War program. This is due to the great quantities of sulfuric acid consumed by peacetime industries. Our sulfur problem during the early stages of World War I was a sorry one, however. Prior to that time, most of our sulfuric acid was prepared from Spanish pyrites, a sulfur ore. Prior to 1917, we were able to obtain all our requirements of pyrites, but soon after the initiation of unrestricted submarine warfare, shipments from Spain became increasingly difficult. We turned more and more to our domestic pyrites, but, in 1918, we found our sulfuric acid requirements for the next 12 months at approximately 8,000,000 tons, with sufficient raw material on hand for only 5,000,000 tons.

Perhaps the situation was fortunate —it resulted in the birth of a new American industry. In 1916, drilling near Martagorda, Texas, indicated the presence of large amounts of brimstone underground. Early in 1918, the government pushed exploitation of these resources without further delay. Since that time, there has been a marked development of our brimstone sulfur resources. Today, this greatly overshadows all other sources of raw material for sulfuric acid production. At present we have over 4,000,000 tons of brimstone on hand, representing over one and one-half times the highest annual consumption of American sulfur during any one period up to the present time.

Other strategic war materials in the realm of chemistry include petroleum, rubber, synthetic fabrics, plastics, activated carbon, drugs, pharmaceuticals, and the like. It is interesting to note that we now have from two to three years supplies of such important drugs as quinine, iodine, and opium on hand.

Just as the American chemical industry is better prepared now than in 1914-18, so is the American chemical profession. During World War I, plants established by the government, such as the chlorine and phosgene plants in Maryland, the Lewisite plant in Ohio, and the cyanide plant in Virginia, availed themselves of nearly every chemist who could be found. Today, most of this type of material is being produced by government-financed or subsidized plants and operated by private corporations. In contrast with World War I days, we have the world's most highly developed and efficiently operated chemical industry, an industry which literally produces dozens of new products daily. Our chemical industry is no longer an infant, but holds a high position in America's list of great industries. We have thousands of chemists and chemical engineers educated and experienced in this highly specialized work.

Research, especially chemical research, always will be our first line of defense and offense. We must remember that despite the vast magnitude of the present emergency program, it is of a comparatively rapid, short-range nature. As Sidney D. Kirkpatrick, President of the American Institute of Chemical Engineers, states: "We should not entirely overlook the fact that some time in the indefinite future we are coming to D-Day. Industry is going to have to be De-mobilized (or perhaps Re-mobilized) for Peace." With this thought in mind, company executives and research directors of far reaching vision and imagination are beginning to plan their remedies for reducing the great post-emergency headache to the smallest possible pain.

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TO REPLACE COPPER

Thermoplastic Tubing is Chemically Resistant

A FLEXIBLE, semi-transparent tubing of thermoplastic Saran is now available to the chemical industry as an alternative for copper and other metal tubings, according to The Dow Chemical Company.

Developed through years of research, this tough, chemically resistant tubing may be used in many applications previously demanding copper except where high temperatures and very high pressures are encountered. Also, Saran tubing has been tested and proved suitable to replace such strategic materials as nickel, stainless steel, copper, and ceramics in several fields where its properties are advantageous.

Saran is characterized by toughness and resistance to moisture, brines, solvents, acids, and alkalies. Another feature of this plastic material is that it may be used for short periods of time at temperatures of 250 to 275 degrees, Fahrenheit, although its strength and resistance are somewhat reduced at these elevated temperatures.

Available in sizes one-eighth inch to five-sixteenths inch outside diameter with wall thicknesses varying from .030 inches to .062 inches, this tubing may be joined by Parker standard tube couplings and S.A.E. or other flare type fittings. Already the Mueller Brass Company is developing fittings for Saran tubing which permit the construction of a tubing system in which contact between such fittings and the material conveyed is entirely eliminated.

EYES OF DEFENSE

Instruments Made on Production Basis

MECHANIZATION, the basis of modern warfare as contrasted even to World War I, depends for its every movement, as well as for many actual combat actions, on information supplied by instruments. Anti-aircraft guns get their range by instruments. On an airplane cowl is a bewildering array of dials. Even the tank must have its two-way radio or its range finders. Almost any implement of warfare, beyond the rifle, has its operator watching the movement of a slender dial needle.

The production of the millions of instruments needed for defense has imposed on the instrument maker the greatest burden he has ever known. How well he does his job will affect the outcome of the world struggle. A look at the results to date are reas-

suring. For example, Uncle Sam urgently needed 5000 D.C. switchboard ammeters in a variety of ranges as part of a mine-sweeper modernization program. Although this represents a normal year's production of this type instrument for Westinghouse, the 5000 were built and delivered to a half dozen navy yards in 28 calendar days. This is one concrete refutation of the often-heard charges of lagging production. Unseen behind this achievement lies progressive engineering that has created the relatively few but interchangeable parts needed, and coordination of products and methods that has nullified the disturbing effect of a wide variety of sizes and types. It is, in short, a tribute to the production-line, interchangeable-part idea that, fortunately for our defense program, has been so successfully incorporated into instrument manufacture just in time for the present emergency. It shows one thing more—the remarkable elasticity of the production-line system—the weapon with which the democracies will outfight totalitarianism.

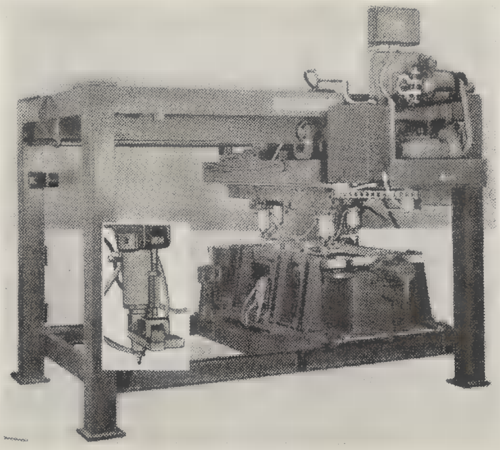
In addition to the thousands of standard instruments, there are many new types that have called for the utmost in engineering ingenuity, but which for military expedience must now be secret. In this group are those for aircraft blind landings, for protection of vessels against magnetic mines, and scores of new aircraft radio instruments.

WALKING WELDERS

Make 80 Spot Welds in 12 Seconds

KNEE-ACTION walking welding guns are the latest innovation in the resistance welding field. Developed by Progressive Welder Company, they permit performing of multiple welds in sequence in an automatic machine, where it is preferable to hold the work stationary in large fixtures. The manner in which this is done is illustrated in a machine developed for welding the back panel into a refrigerator shell.

The machine is designed to handle two sizes of such shells, and welds one assembly while another is being loaded and unloaded. Shell and back panel are dropped over the locating fixture, which incorporates the lower electrode. Clamping is by air pressure. (One fixture has been removed, in the photograph, to show the clamping mechanism at the side of the fixture.) When a button is pressed, the entire operating head of the machine moves to a position above the loaded fixture. Pushing another button starts the automatic welding operation. The four gun points come down and make four welds. At the same time the chain has started to move. The motion of this chain is continuous, carrying the heads of the welding guns along. Weld time is controlled by an electronic timer. When the weld is completed, the pressure is off the gun points, and these points swing—under spring pressure—to a new position farther along (depending on the amount the chain has moved). Another weld is made automatically, and the guns take another step.



Push-button operated

To complete one assembly, each gun takes 19 steps and makes 20 welds, 1½ inches apart. While the shell is being welded, the other fixture is being unloaded and re-loaded. The machine operating head now moves above over the second fixture and repeats the cycle, except that the movement of the guns is now in the opposite direction, the chain reversing its travel at the end of each complete cycle of welds. Off-time, between welds, to permit the guns to move on to the next spot before welding current comes on, is controlled automatically by a notched timing disk.

Time for the complete welding cycle is approximately 12 seconds, during which time 80 spot welds are made.

SCRAP NICKEL

Recovery Possibilities Up To 1,000,000 Pounds a Month

FROM 20 to 40 percent of the total tonnage of alloy steels delivered by mills to manufacturers are lost in machining and other processes of fabrication. Sometimes net losses may run to 70 percent, and—in complicated operations—up to 80 percent. Nickel content in the case of automotive and similar type low-alloy steels runs from slightly over 1 percent to over 5 percent. In stainless steels the figure often may rise above 10 percent.

The alloying elements in these materials are largely reclaimable, but in the past most of them have been lost—though the stainless steels, to an extent, have been an exception. They have been lost by a general practice of mixing the alloy-steel scrap with carbon-steel scrap and disposing of it as carbon steel. The extent of this practice is indicated by the fact that in the past year the residual nickel content in miscellaneous scrap as revealed by periodic examinations was approximately 0.05 percent.

This residual nickel enters carbon steel through alloy steel mixed with ordinary carbon-steel scrap charged into the furnaces with pig iron. An average of 50 percent scrap is used in the usual furnace charge. In other words, this nickel enters by mistake or failure to segregate alloy from carbon-steel scrap. It is too low in content to add appreciably to the qualities of the steel. It remains buried but under proper conditions could have been saved.

During the past year approximately 70,000,000 tons of steel were produced. At the average figure of 0.05 percent residual nickel this tonnage would account for 70,000,000 pounds of nickel. This nickel might well have been salvaged had scrap segregation been systematically carried out over the years in which, through cumulative effect, this quantity of residual nickel was being built up.

Steel production is mounting rapidly. During the first eight months of 1941, for instance, more scrap was used than in any other year of the steel industry's history. Hence the concern of both government and industrial leaders for an intensified nation-wide salvage campaign.

As indicated, segregation is the springboard for recovery of essential alloying elements. It means far more, of course, than segregation of alloy-steel scrap from carbon-steel scrap. No general specifications for such segregation according to percentage of nickel content have yet been completely outlined, though numerous divisions along these lines not only have suggested themselves, but also are being carried out in a number of cases.

While all scrap containing nickel is valuable and should be segregated so that the nickel content can be salvaged, it should be obvious that scrap containing 2½ per cent nickel or higher is far more valuable to the producing mills than scrap which, through dilution, runs 1½ per cent nickel or under. On the basis of present nickel-steel consumption it is estimated that up to 1,000,000 pounds of nickel a month may be saved for producers and users of these nickel-steels by careful scrap segregation.—*Inco.*

INDUSTRIAL TRENDS

DOWN TO THE SEA FOR METAL

If ever a search were conducted for the most versatile metal in commercial production, magnesium would probably finish at the head of the list. One third lighter than aluminum, it can readily be used in alloys of light weight and outstanding strength. Such alloys, usually involving aluminum, zinc, and manganese, are easy to machine. An example of the resulting light weight of these alloys is found in magnesium alloy wheels for large bombers, which, substituted for aluminum wheels, show a weight saving of some 100 pounds.

But weight and strength alone would not be sufficient to place magnesium at the top in versatility. It has other qualities that are of particular interest in wartime, yet are not unusable in times of peace. Thus, the metal can be ignited to burn at the intense heat of 1300 degrees, Centigrade, giving off at the same time a brilliant light. If water is poured on the burning metal a violent explosion takes place. Direct a stream from a carbon tetrachloride fire extinguisher on such a fire and the deadly gas phosgene is evolved. Ignite a quantity of the metal in powdered form and an explosion will occur. These oxygen-hungry properties of magnesium make it ideal for use in incendiary bombs, tracer bullets, flares, and other wartime applications.

It is not to be wondered at, then, that production of magnesium is being stepped up many times in an endeavor to make full use of its qualities for the diversity of purposes of war into which it fits. Yet, strangely enough, there was no commercial production of this metal in the United States until 1915, when supplies from Germany were cut off by World War I. During that year only about 87,000 pounds were produced in the United States; scheduled production for 1942 is several hundred thousand pounds.

Like aluminum, magnesium does not occur as a free metal in nature. There are large quantities of magnesium-bearing ores in existence in some of the western states, but the principal source of the metal is brine from the ocean or from salt wells in the middle west. From these brines is extracted magnesium chloride which, in turn, is subjected to an electrolysis process to obtain the pure metal. Another method involves the reduction of magnesium oxide through the use of carbon and electricity, hydrogen being used in one of the steps to obtain the free metal. Still a third process has been developed, known as the ferro-silicon process, which, it is claimed, uses less electricity than other methods, and is less expensive in other phases.

Be that as it may, the one company in the United States that has pioneered in magnesium production, and which undoubtedly can most definitely be depended upon to indicate the present and future trends in the industry, is the Dow Chemical Company. With extraction plants at various ocean fronts and with brine wells in the middle west, this company is not only a metal producer but a fabricator as well. In such a position, and with huge expansion plans for war purposes well underway, this company, together with ten others now in the field, may seem to be in the position of war babies that will some day find themselves so over-expanded as to face possible industrial disaster.

Such disaster might indeed be a possibility if it were not for two important factors. First, potential uses of magnesium in industry are just beginning to be explored. Second, Dow's operations in the extraction of magnesium from brine are only a part of a chemical business using the same basic material. From the same source are being obtained such varied finished products as bromine, iodine, alkalies, chlorine, and so on—all chemicals with huge present and potential demands.

But to stick to magnesium for a moment: Increased production and improved methods have already resulted in decreased costs which may be expected to decrease still further as production is stepped up. This factor alone has made it possible to invade many fields hitherto closed to the metal. Aviation is, of course, the most obvious and the one that is receiving the greatest attention at the moment. It naturally follows, then, that the lessons being learned in building military aircraft are going to be applied to the aircraft industry of peacetime, and that magnesium alloys are going to loom large in plans of the industry after the war. Then there are the fields of the automobile, the railroads, the electrical industry, all of which will welcome the advantages to be had from magnesium alloys made available through low cost of the pure metal. Household appliances such as washing machines, vacuum cleaners, fans, and so on, when once more put into production, will find wide use for the light, strong, inexpensive alloys.

With these facts alone in mind, the trend of the magnesium industry is a healthy one for the war of the present and the peace of the future. Couple it with the extraction of other raw materials from brine, mentioned above, and salt water, in the hands of the chemist, promises to loom large in the industrial picture.

GLUE RELEASES STEEL

That this is an age of metals, and that this war is a war of metals, is one of those obvious truisms that upon investigation discloses other factors which render the truism only partly correct. While the demands of armaments have thrust metals to the fore, these same demands have created vastly increased uses for man's oldest constructional material—wood. And these increased uses are not only in civilian fields where wood is employed as an alternate for steel, but for military purposes as well, where strength is needed but where the other qualities of metals are unnecessary.

One of the factors that have contributed largely to satisfactory applications of wood in a diversity of uses has been the development of glues which are strong, weather resistant, easily applied, and not attacked by the fungus growths that can render some glues unsatisfactory for use over extended periods of time.

Indicative of the trend in the glue industry is the fact that many government projects are using laminated arches made up of layers of wood securely bonded with glue. These arches are going into the construction of airplane hangars, armories, ship-building sheds, and factories. In addition, thousands of government workers as well as service men are being housed in dwellings of glued construction. In California alone, it is reported, there are some 5000 living units of this type.

Aside from the savings that can be realized in structural steel through such wood and glue construction, there is the saving in nails which, at first glance, might seem unimportant. But, it is estimated, 100 pounds of nails are saved in every FWA home now being put together with glue. Multiply this by many thousand units and the sum total certainly indicates a trend in future building construction.

—*The Editors*

OUR *Point* OF VIEW

THE LONE INVENTOR

Edison, Howe, Whitney, and a host of others are names that conjure up visions of the lone inventor. Working long, weary hours, often under circumstances of dire need, even hunger, these men struggled on, reached the pinnacle of success through sheer inventive genius. That they often worked alone may have been a fortunate circumstance rather than a serious handicap. Coming before the era of inventors backed by the almost unlimited resources of the modern industrial research laboratories, these men have become symbolic of a period in the development of our country which often but erroneously is thought to be gone forever.

True enough, inventing has today been brought to such a point of perfection by industry that casual consideration of the subject might easily lead to the conclusion that the day of the lone inventor is past. How far from actuality would be such a conclusion may be found by skimming the weekly list of United States patents issued, as published in the Official Gazette of the United States Patent Office. Here will be found recorded official recognition of hundreds upon hundreds of the brain children of individual inventors who have labored as faithfully, suffered as keenly, struggled as heroically as any of the honored inventors of the past three generations whose names are now part of our nation's industrial and scientific history. And—what is even more important to many—these brain children frequently form the foundation of fortunes for the men who gave them birth.

No, indeed, the day of the lone inventor has not vanished. Today the opportunity for individual effort is as great as, if not greater than, ever before. Thousands of keen minds, rendered even keener by the pressure of industrial production necessitated by the exigencies of war, are at work throughout the country on new, often strange jobs, turning out the materiel demanded by our armed forces. As these minds are applied to the problems at hand, they are absorbing new knowledge, finding new ways of doing things better, faster, more easily. And, relaxing during hours off the job, these minds often and naturally dwell on the work of the day and of days to come.

What is more to be expected, then, than to find the possessors of these minds turning to home workshops and laboratories to try out new ideas, to experiment with some new twist that flashed out of a seeming nowhere into a receptive medium?

Those whose intellectual curiosity or mechanical talent constantly urges them onward into fields of exploration have a bright and fruitful future ahead. They must not let the war ruin their perspective but, rather, should take every advantage of the opportunities being offered by the demands of the moment. There is great need of inventions for furthering our war efforts to a successful conclusion; there is likewise great need for inventions in civilian lines, particularly for use after the war.

If, then, the individual inventor, as he develops his ideas, finds that some of them have no apparent applications today, he should not too quickly abandon them. Careful scrutiny may indicate future possibilities. Such inventions should be just as thoroughly protected as if they were going into production tomorrow; lack of foresight in this respect may lead to bitter disappointment and financial loss in the future. The effort and investment needed to obtain such protection is relatively small when compared with the losses that may be sustained when the need for the invention is discovered and it is found that protection is lacking.—*A. P. P.*

FOR BETTER SHOOTING

In the April and May issues of *Field & Stream*, Arms and Ammunition Editor Bob Nichols describes a new type of gun-mount, adaptable to .50-caliber machine guns and 37-mm anti-tank guns. The compelling feature of this mount is its maneuverability which, while revolutionary compared to existing military usage for this class of fire power, is an old story to the American bird hunter. Like the shotgun at the hunter's shoulder, the machine gun or anti-tank gun, through application of this mount, may be rotarily swung through 360 degrees. Coincidentally with the rotary movement it can be elevated or depressed 90 degrees. In a quoted letter appearing in one of the *Field & Stream* articles, the gun-mount inventor states the Army and Navy are "trying to hit dive-bombers and low-strafing planes with slow, fixed gun-mounts—too heavy and too slow to swing on the target . . . using three men to aim, sight, and fire one gun—an attempted co-ordination that is impossible to achieve in the split-second time allowed on fast-moving, twisting, and diving targets." Although presentation of the mount was made last January before all branches of the service and, writes the inventor: "all tests were completed successfully—and the test operator ended up by shooting a buzzard out of the air at least 500 yards out," there has, at this writing, been no official adoption of the mount. While we are not in a position to substantiate the inventor's claims for the physical perfection of his mount, we heartily subscribe to the theory of maneuverability involved—as old, as tried, and as true as the technique of shooting game birds on the wing, or jackrabbits on the hop. In either offensive or defensive warfare the adoption of the theory of properly leading a speeding target—a theory proved sound by generations of American hunters—would, we believe, make it possible to knock more enemy planes and tanks out of action.—*A. D. R., IV.*

NAVAL ARTICLES

In our issue for May we presented an analytical article on the battleships of the United States Navy, the article to be the first of a series. The present number does not carry the second article because of the war-time censorship to which Scientific American has voluntarily submitted. The manuscript of the second article was submitted to the Navy Department for approval, but such approval was not granted. As soon as we can obtain clearance, in a form satisfactory to the Navy Department and to the Office of Censorship, these articles will be published.—*O. D. M.*

Harnessing the Sun

Research on the Practical Problem of Power and Heat from the Sun: A Progress Report from M. I. T.

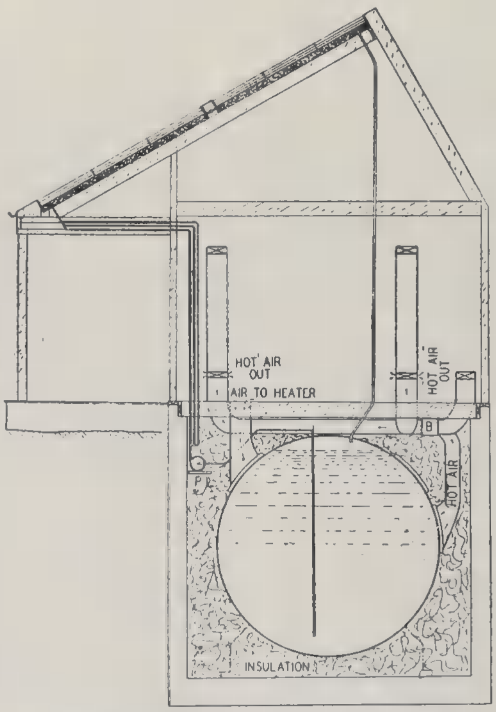
JOHN A. SIBLEY

As man's society becomes more and more complex, his energy requirements increase at an immense rate. The cave man, whose only need was about 2000 calories of food a day, used the equivalent of about one half pound of good-grade bituminous coal per day, or about 200 pounds per year. Yet a modern man, living in the midst of thousands of mechanical devices which require energy both in their manufacture and use, consumes over ten tons of equivalent coal a year, or over a hundred times the energy actually needed by the body. This rate is constantly increasing; the last 60 years, during which America has changed from a young agricultural nation to the most highly industrialized nation in the world, have seen this country's fuel requirements increase six-fold. As technological advances are being made every day, there is little doubt that an even greater supply of energy will be needed in the future.

The sources of energy have likewise changed. During this same 60-year period, wood has declined in importance from 60 percent of the total to only 6 percent. Coal rose to a peak of about 80 percent in 1918 and then decreased due to the development of the oil industry. At the present time anthracite and bituminous coal supply about 45 percent of the total; petroleum and natural gas supply about 36 percent; water power supplies about 10 percent; and the small remainder is furnished by wood, food, and wind. With the exception of wind and water, the supplies of these materials are being rapidly depleted, and, although the problem at present is far from urgent, they may eventually be entirely used up.

For many years scientists have realized the need of developing a new source of fuel and have been considering the possibility of employing the vast amount of energy which is constantly being received from the sun. The earth and its atmosphere intercept the equivalent of 21 billion tons of good coal per hour, which means that in three minutes enough energy is received to equal America's consumption for one year. In the past, many devices have been built in an attempt to tap this immense flow of power, yet the results of these early experiments have been unrelated and undecisive. These inventions worked with varying degrees of success, but, until two years ago, when Dr. Godfrey Cabot's gifts to Harvard and the Massachusetts Institute of Technology made possible the establishment of research programs at the two schools, no scientific inquiry into the basic problems of solar energy conservation had been made. The Harvard group is primarily concerned with an investigation of the chemistry of photosynthesis, while a committee of the Institute is studying the physical problems of energy collection and utilization.

Courtesy *The Tech Engineering News*



Sectional view of solar energy building described in the text

Before proceeding further with a discussion of solar power perhaps it would be well to destroy the optimistic picture which is given by the above figures of the amount of solar energy available. They are based on the amount received per acre of surface at a point outside the earth's atmosphere and normal to the sun's rays, which energy at noon reaches a total of about 7500 horsepower. Of this power only about 5000 horsepower reaches the surface of the earth. If this energy is used to operate a heat engine, allowance must be made for the efficiency of collection as heat in a fluid, and the energy rate drops to 3300 horsepower. Taking the highest attained value for the efficiency of converting such heat to useful power, the horsepower becomes only 490.

Thus far the calculations have been based upon sunlight normal to the surface of the collector. If the collecting system is mounted to follow the sun, in order to fulfill this condition, the different units of the system must be separated so that they do not shade each other during part of the day. Allowing a ground coverage factor of one third, the horsepower is cut to 163. Converting this figure to power over a 24-hour period in summer in Arizona, the output becomes 83, or in winter 68, horsepower. Finally, considering the average number of clear days in New York the actual horsepower per acre is 50, only one 150th of the initial figure.

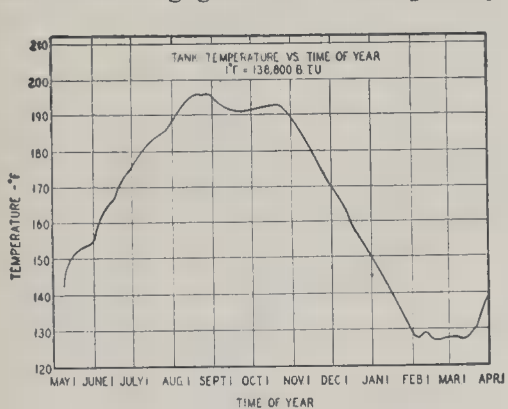
One may evaluate this answer in terms of dollars and cents and hence roughly determine the economic feasibility of employing solar power. Assuming that electrical power can be produced in a large modern plant at .6 cents per kilowatt hour, or $53 per kilowatt year, the output of a one-acre plant is worth $1900 a year. Figures on labor costs and maintenance are lacking, but optimistically assuming a high capitalization of 15 percent, there is $13,000 to spend on the entire plant, or $2.60 per square yard. As ground coverage was only one third, $8.00 is available to construct each square yard of reflectors, mountings, and accessories. This value is quite low and shows how slim the margin of profit is at present on a solar energy plant. It is evident that the degree to which solar power is to be utilized in the future depends upon the increase of these efficiencies, and it is toward this end that the research is being devoted.

The first project in the solar research program at Massachusetts Institute of Technology is the study of different types of collectors and the development of one with the highest possible efficiency. The type of collector which has been perfected to the greatest degree is the simple, flat-plate type. It consists of a sheet of metal, or a body of some other material such as water, sulfur dioxide, or even sand which is heated by the sunlight. The bottom side of the plate is insulated and the top side is covered by a sheet of glass parallel to it with about an inch of air space between. When thus covered,

the plate receives practically as much sunlight as before, the glass transmitting about 90 percent, but the losses from the plate to the atmosphere are greatly reduced, the convection losses being eliminated due to forced stagnation of the air, and the radiation losses being eliminated because the glass, although transparent to the sun's rays, is opaque to the long-wave infra-red radiation emitted by the hot plate. Variations in this design include the provision of vacuum spaces instead of dead air spaces, and employing several glass plates instead of one.

As each additional layer of glass cuts down the losses, one would suspect that with sufficient layers a perfect collector could be built, yet this is not the case. It is true that if the right glass is chosen there will be little absorption of the sunlight, but there is a reflection loss of about 4 percent at each surface. Consequently, as one adds more plates, one ultimately reaches a point where the reduction in heat loss from the metal plate is more than offset by the reduction in intensity of incident radiation due to reflection losses. This optimum number of plates varies, being less the greater the heat from sun and more the colder the weather or the hotter the collecting plate.

It was in order to decrease these losses through reflection that the process of coating glass was developed by



Yearly chart of tank temperature

Dr. Turner and Dr. Cartwright whereby the glass has a permanent surface of reflectivity approaching zero at one point of the spectrum. This important discovery has already proved valuable in many other fields, ranging from spectacle lenses to bomb sights. As yet the special glass has not been used in an experimental solar energy collector, but calculations indicate that its use should make possible the attainment of 800 degrees, Fahrenheit, without the use of mirrors, lenses, or other concentrating devices.

A second problem in designing flat-plate collectors is that of optimum tilt. Because of the simplicity of the design, it is more economical to have the

Sun laboratory where the plan to heat a building by solar energy is tested

collectors mounted at a permanent tilt than to have them follow the sun. The angle of tilt depends very definitely on the use to which the collected heat is to be put. If the purpose is the maximum collection of heat during the entire year, tilting should favor the summer months. If, however, the object is to supply heat for a load which varies during the year, the tilt should favor the part of the year during which the load is the greatest.

Of the many uses to which such collectors may be put, perhaps the simplest is the heating of a house in a relatively cold but sunny climate. The system would consist of a well insulated tank from which water can be pumped to the collector and back whenever the collector is hotter than the tank, and a set of radiators through which the hot water could be circulated to heat the building. It was for research into this type of heating that a testing cottage was built on the Massachusetts Institute of Technology grounds. For many months the plan has been put to a practical test, and valuable data are being obtained on the optimum number of glass plates, the best tilt, the ratio of roof to tank area, and the advisability of employing special types of glass.

Another obvious use is the employment of the sun's heat to run a steam engine, a hot-air engine, or similar device which requires a heat reservoir. The cost of power production in a conventional plant depends enormously upon the size of the plant, and, therefore, although the efficiency of solar power plants is small compared to large conventional plants, it nearly equals the efficiency of very small plants. It is not unreasonable to hope that future large solar energy converters will make power as cheaply as a fuel-fed plant.

In order to obtain efficiency in small solar plants, another type of heat engine is being developed—the thermopile. When two dissimilar, conducting materials are joined to form a loop and the junctions kept at different temperatures, heat flows into the loop at the hot junction, a portion of its energy is converted into electrical energy, and the rest flows out as heat at the cold junction. This principal of thermo-electricity has long been known, and the possibility of electrical power production on a large scale by this method has often been considered and always dismissed because the effect is very small. As the result of recent research, the overall efficiency of the best thermopile is about 4 percent, but it is possible that intensive research will increase this value several fold. As the efficiency of the best steam power plants is only 25 percent, a small converter with an efficiency of 5 percent would be of great value. It is toward the development of more effective thermopiles that the second branch of the research program is directed.

In order to form an effective couple, the two metals must have, in addition to high thermo-electric power, a low thermal conductivity in order to minimize the loss of heat flowing from the hot to the cold junction, and a high electrical conductivity so that there

will be low resistance losses. The ratio of thermal to electrical conductivity is known as the Weidemann-Franz ratio, and it is desirous to have this value as low as possible. Experiments have shown that alloys of zinc and antimony have a surprisingly low Weidemann-Franz ratio while retaining a high thermo-electric power. By using an alloy of 43 percent zinc in antimony against a Copel alloy with a temperature difference of 400°, Centigrade, a moderately effective engine is formed.

Thus far, only the so-called heat engines have been discussed. Both steam engines and thermocouples are devices which receive energy at a certain temperature, convert part of this energy to useful power, and throw away the rest to a so-called heat sink at a lower temperature, and, therefore, their efficiency is limited by the Second Law of Thermodynamics. It is this law which states that the efficiency of a heat engine cannot be greater than the difference of the initial and final temperatures divided by the initial temperature; that was the reason for the sudden reduction of the value of solar power from 3300 to only 490 horsepower. As high efficiencies are thus impossible if only the heat from the sun's rays is employed, scientists have been examining other properties of this radiation in the hope of finding other more profitable methods of power conversion.

It has been found that the light quanta are able to knock electrons out of atoms or atomic lattices in crystals and produce an electric current, a phenomenon known as photo-electricity. This property of light is employed in camera exposure meters in which the current generated moves a galvanometer needle, and thus measures intensity of illumination, and it is the project of the third branch of solar research at Massachusetts Institute of Technology to see whether this same method is applicable to large scale current generation.

The light-sensitive unit of such a device is known as a blocking layer photo cell, of which the copper oxide cell is typical. It consists of a massive plate of copper which has been oxidized on one side and then etched, thus producing a layer grading from cuprous oxide through all proportions of oxygen down to pure copper. The cuprous oxide surface is coated with a very thin layer of some other metal, so thin that it is transparent to light quanta. A light quantum, on hitting the cell, passes through the metal cover and the cuprous oxide into the layer of composition varying between copper and cuprous oxide, the so-called blocking layer. Here it succeeds in breaking an electron away from the crystal lattice, and this electron finds it easier to migrate toward the copper than through the copper oxide to the metal film. This unidirectional motion of the electrons constitutes an electric current.

How important is this phenomenon in generating power from sunlight? Quantitative experiments have shown that of the visible light quanta falling on a cell only 5 percent succeed in freeing an electron, and that the voltage efficiency is about 10 percent. The overall efficiency is, therefore, only .5 percent, but, as in the thermocouple, it is possible that this efficiency may be increased as much as tenfold. Such an accomplishment will not be easy, however, for physicists actually know very little about what goes on in the blocking layer of a photo cell. In order to supply these data, a research project is being initiated in the Electrical Engineering Department in connection with a broad program of study of insulators and semi-conductors, from the viewpoint of atomic physics.

The last of the Massachusetts Institute of Technology solar energy projects, like the one just discussed, depends upon the special properties of sunlight rather than on its overall energy content. Everyone is familiar with the basic action in plant leaves whereby carbon dioxide and water are converted into carbohydrates and oxygen by means of sunlight in the presence of the catalyst chlorophyll. If man were able to copy nature and utilize light to produce substances of high energy content, a vast supply of power would become available. This does not mean that research should necessarily be directed toward reproducing photosynthesis in the test tube, but rather it should search for the necessary catalysts and conditions which would allow one to carry out some simple energy-storing reaction like the decomposition of water. A major problem would be to devise a reaction with suitable intermediate steps, in order that the small energy quanta of which light is composed could be employed one step at a time, just as nature undoubtedly does in the leaf of green plants.

Research at Massachusetts Institute of Technology, however, is approaching this problem somewhat differently. Rather than attempt to produce a stable product of great energy content, such as fuel or explosive, one may attempt to capture the energy of the intermediate products and convert it into electricity. It is necessary to find a photo-chemical reaction in which the passage from an unstable to stable state can be made to proceed as the electrode reaction in a cell. Such an oxidation-reduction reaction which is now being carefully studied consists of an organic dye, thionine, and ferrous iron in the form of a ferrous sulfate solution. The reaction can be represented in the following reversible equation.

$$\text{dye} + Fe^{++} = \text{leukodye (colorless)} + Fe^{+++}$$

Ferric iron is a much stronger oxidizing agent than thionine; therefore, in the dark, all the thionine is in the form of the dye, and the iron in the reduced state. If the mixture is exposed to light in the range absorbed by thionine—visible light from 5000 to 7000 angstroms—the thionine molecules become capable of oxidizing ferrous iron. As the leuko compound is colorless, the reaction can be followed by watching the decolorization of the solution. This is the most light-sensitive reaction which has yet been discovered. As the composition of the solution changes by illumination, its electrode potential also changes. If two platinum electrodes are placed in the solution and one is illuminated and the other kept dark, a potential difference is established and a current flows from the dark to the illuminated electrode.

There are two qualities of such a cell which must be determined if its industrial importance is to be ascertained: first the electromotive force produced by a given light intensity, and second the current which may be drawn from the cell. The variations in potential with intensity of light, with different concentrations of thionine and iron, and with solutions of different *pH* have been studied and optimum values determined. In order to produce power efficiently, the cell must be able to give a strong, steady current, but whether or not such efficiency can be hoped for it is too early to say.

Thus research on converting the sun's rays to useful power has only begun. Latest advances indicate that the likely fuel supply of the future is sun.

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FUNNELS

Stainless Steel Saves Over Four Tons Per Stack

Destroyers—often referred to as the "greyhounds" of the battle fleet—are required to operate on a comparatively low displacement, so that they can readily attain the high speeds essential to their effective use. Every ton of material that goes into the structure of a vessel of this class of warship, consequently, is given careful consideration.

Just recently, for example, it was an-

nounced that the United States Navy's newest destroyers will carry stainless-steel funnels. These funnels are said to be $4\frac{1}{2}$ tons lighter than the type used on destroyers built in previous years. This means that additional armor, guns, and torpedoes can be carried.

Even though the sections of metal used in these funnels are relatively thin, the resulting structures are remarkably sturdy because of the high strength of the stainless steel, their welded construction, and the fact that adequate reinforcement is provided by corrugated stiffeners. The metal's resistance to the corrosive action of salt air and exhaust fumes, and its resistance to shock, should also provide added safely under stresses to which they will be subjected when placed in naval service.

REFRIGERATED

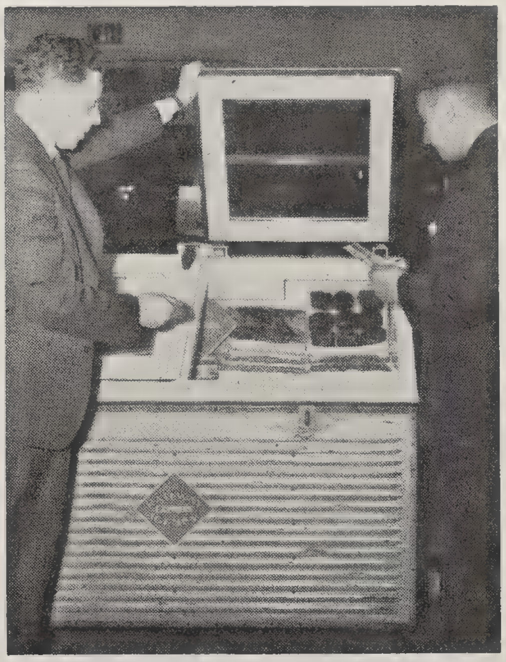
Containers for Express Shipments

A marked increase in variety of perishable commodities moving in its "refriger-ex" service has been noted recently by the Railway Express Agency; the system involves the use of refrigerated containers especially designed for less-than-carload-lot movement in express service.

The boxes, which are mounted on casters for easy handling, permit inside temperatures from below zero to levels above the freezing point and upwards. Dry ice is employed as refrigerant for extremely low temperatures and regular ice for those of more moderate ranges. Quick-frozen foods and some serums, vaccines, and medical supplies usually require below-zero facilities of the container.

The greatest traffic increases in the field, however, have been for products calling for water ice refrigeration. A number of containers, for example, are assigned to the movement of blood donations, in hermetically sealed bottles, from Red Cross stations in large cities to the processing plant in each area, for the production of dry plasma transfusion units.

The Church container is also being used on an expanding scale by large oyster shippers at Chesapeake Bay points, in getting the shucked product to dealers over a wider area. Fifty two-gallon cans can be placed in a container, making a shipment load of 418 pounds.



With portable display top

The containers have likewise been found advantageous for LCL express movement of ice cream, dressed poultry, frozen foods, fruits, vegetables and seafood, meat, hatching eggs, and a miscellany of other perishable products including serums, laboratory specimens, and unexposed motion picture film stock. When they arrive at their destination they may be equipped with a portable glass top, enabling consignees to use them as refrigerated display cases, paying only a nominal fee for retaining the boxes as long as needed.

In transit

TRUCKS

Urged to Replace Railway Mail Service

Establishment of additional highway post office routes as substitutes for abandoned railway service is recommended by Smith W. Purdum, second assistant postmaster general. Efficiency of such routes is evidenced by the fact that three highway mail routes, using specially built trucks, were established about a year ago by congressional authority to substitute for abandoned railway mail service between Washington, D. C., and Harrisonburg, Virginia; South Bend and Indianapolis, Indiana; and San Francisco and Pacific Grove. California.

LIGHTNING

Continuing Studies Trap Biggest Bolt

Bolts of lightning hurtling down twin copper cables on a smelter stack 30 feet taller than the 555-foot Washington Monument, have been studied for science by engineer-detectives in Anaconda, Montana. One bolt was the most powerful direct stroke of lightning ever recorded. Its current totaled more than 160,000 amperes.

This investigation is part of a nation-wide effort to learn more about lightning, hence more about how to protect power lines and electrical apparatus from damage and resulting inconvenience or loss to power users.

Sponsor of the study is the Westinghouse Electric & Manufacturing Company, whose research engineers developed the "fulchronograph," a device which enables accurate measurement of the intensity and duration of lightning strokes. Co-operating in the work are engineers for the Anaconda Copper Mining Company and The Montana Power Company.

"Current in the most powerful bolt recorded probably totaled about 200,000 amperes," W. E. Lee, Westinghouse representative, said. "Unfortunately, range of the measuring device was only 160,000 amperes. Needless to say, capacity of the instrument was increased to 200,000 amperes immediately."

Although voltage of the stroke was not measured, it is estimated that approximately 15,000,000 volts would be required at the top of the stack, to cause the fulchronograph to register 160,000 amperes at the bottom. Momentary energy of the stroke probably totaled nearly two and one-half billion killowatts.

If such an immense amount of energy could be produced steadily at some gargantuan power plant, output of that plant would be approximately 57 times greater than the total installed capacity of all the nation's generating stations. Total installed generating capacity of U. S. power plants was 42,435,863 kilowatts as of June 1, 1941.

"Bait" in the lightning "trap" at Anaconda comprises 20 vertical one-inch copper rods, five feet long. Mounted in a copper ring 60 feet in diameter which encircles the top of the stack, these rods extend skyward like spikes on a coronet. Each spike is coated with

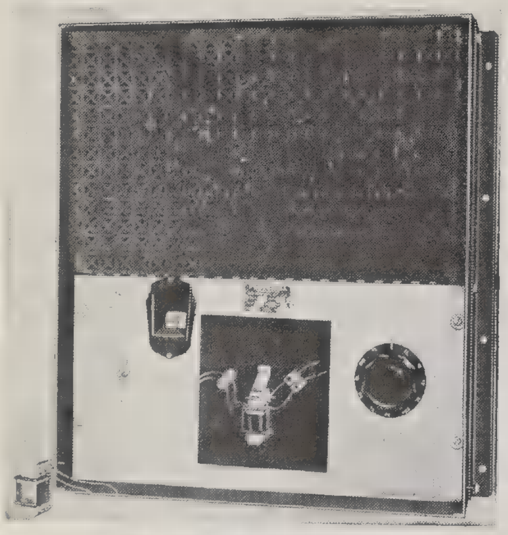
lead to protect it from hot flue gases, and tipped with hard metal alloy to enable it to resist destruction as a bolt strikes. Two copper cables connect the ring atop the stack to the fulchronograph, which is installed in a small building at the base of the stack. Essentially, the fulchronograph comprises an electric motor and a slotted aluminum wheel, the rim of which is filled with small strips of magnet steel projecting like fins and rotating through two coils. The coils carry current from the lightning stroke being measured.

Current in the coils produces a magnetic field which is proportional to the surges of lightning current. The steel fin on the recording wheel which happens to be passing the coils at a given instant is magnetized in proportion to the amount of current carried by the stroke, in time divisions as brief as 40 millionths of a second. Characteristics of the stroke may be determined by the number of fins magnetized, and the degree of magnetization.

COIL TESTING

Quickly Done With New Machine

Coil testing machines, for quickly determining all of the electrical properties of a coil in one handling, are now available for checking the limits of insulation resistance, coil resistance,



Eleven tests, quickly

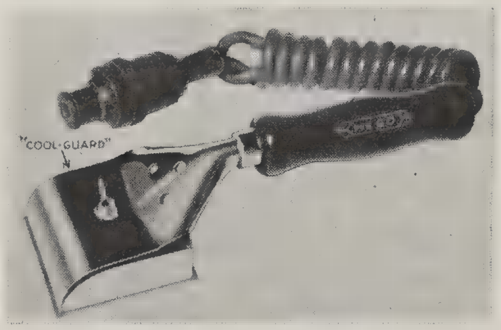
effective A.C. resistance, inductance, and shorted turns, as well as for checking effective turns, direction of windings, and other important properties. There are two types of machines: automatic and semi-automatic, each having holders adapted to the special shapes of coils to be tested.

One of our photographs shows a machine of the semi-automatic type, capable of making eleven tests in quick succession on each coil, and checking up to 250 coils per hour. In using this machine the operator attaches the coil to holder at center of panel, pushes terminal wires into spring clips, and turns the large knob one step at a time. The design is such that at each step the pointer of the illuminated galvanometer must cross the center of its dial by moving from left to right, or from right to left. The operator watches for this movement; if it occurs, he knows that the coil has passed that test. If the pointer does not cross the center of the dial for some one test, then the nature of the defect in that coil is shown by lettering on the knob.

PAINT STRIPPER

Heats and Scrapes With Same Unit

An electrically heated tool which heats painted surfaces and wet wallpaper surfaces, and then permits the operator to scrape the surface with the



Pull . . . push, to remove paint

same unit, can be operated on any conventional 110 volt A.C. or D.C. circuit. This new device, manufactured by the Heating Equipment Company and illustrated in one of our photographs, has a flat heating surface. When used for removing old paint or wallpaper which has been wetted, the heating surface is applied and drawn over the paint or paper. A prompt forward thrust of the scraping edge cleans the surface of paint or paper, stripping it off without burning.

The square scraping plate is regrindable or replaceable and has four interchangeable sharp edges. It is claimed that the heat from the unit keeps the scraper plate clean.

WAR GASOLINE

Sold to Public Contributes to Aviation Fuel

Automobile owners are contributing to the huge stock of high-test aviation gasoline with which the United States proposes to win the war. This contribution is being made in a new war-time motor gasoline, now being sold at most gasoline stations, according to Robert H. Colley, president of The Atlantic Refining Company.

"The new war-time gasoline starts just as easily on a cold morning, and in most automobiles will give just as good performance and yield just as much mileage. For that reason 95 percent of the automobile owners will not notice that there is a difference between it and the gasoline they used to buy at the service station on the corner," Mr. Colley explained.

"All gasoline blends are a complex mixture of petroleum compounds. Part are found naturally in crude oil. Others are products of the 'cracking' process. Some have a fairly high octane rating. But usually other substances have to be added to give the blend a sufficiently high anti-knock value. In most cases tetraethyl lead is the substance used. In others additional high-octane petroleum products are added.

"Both these added substances are needed by the government to assure adequate reserves of aviation gasoline to meet any possible emergency, and to obtain the amounts required, the precious tetraethyl lead supplies have been rationed and the high-octane petroleum products requisitioned.

"In order to produce a gallon of high-test aviation gasoline it is necessary to strip 16 gallons of motor gasoline of these high-octane components. To this is added a petroleum hydrocarbon of very high octane value, manufactured from one of the choice components stripped from motor gasoline. Then a final small dose of tetraethyl lead is used to bring the fuel up to the 100-octane mark.

"That explains the difference between the motor gasoline now being sold and that sold a few weeks ago. That difference represents the motorists' contribution to keep American planes flying and help win the war."

BOMBER-FIGHTER

New Dual-Purpose Plane Used by British

A new airplane with a dual personality—fighter as well as bomber—has enabled the British to develop a technique of bombing entirely new even among the novelties of modern aerial warfare. In a day when new planes are being equipped with superchargers to cruise in the heights of the substratosphere, this latest air weapon hugs the ground and even dips into hollows or ravines to hide from enemy fire.

While most bombers are heavy, lumbering craft requiring for protection convoys of fast fighters or the shelter

of high altitudes and masking clouds or darkness, these new ships need no escort and make no attempt at high-altitude flying. With military experts pinning their faith on intricate bombsights, these pilots use no aiming devices at all, according to *Science Service*.

Machine-gun "strafing" from low altitudes is something European fighters have been familiar with since the days of World War I. Dive bombers are by now taken for granted. But this new sort of "horizontal bombing" from planes grazing the tops of the hedges, and whizzing by at 340-mile-an-hour speed, has provided the Germans with a complete surprise.

The British journal *Flight* reports it as fact that the Germans are building 30-foot anti-aircraft towers in order to be able to shoot down on these new bombers.

The new technique has produced its own problems in ballistics. When a bomb hits the ground from such a low height, it ricochets along the ground horizontally and hits the target from the side instead of from above. This is all right for a huge target. But one pilot who watched a companion attack a railway station reports that the bombs went clean through both walls of the station and exploded harmlessly some 300 yards away.

The airplane is in some danger from its own bombs at such low altitudes. In order to be reasonably safe from the explosion of a 250-pound bomb such as those carried by the new Hurricane, an airplane must be at a greater height than 1500 feet—2000 feet would be better. To get around this, delayed-action bombs that do not explode on impact are being used, and formations have abandoned their sentimental attachment for the V symbol in favor of flight abreast. If one plane flew behind the others, the last man would be blown up by the bombs dropped by the leader.

The regular procedure has been this. The planes cross the channel flying in formation at economical cruising speed. As soon as the coast of France is reached, they throw the throttles wide open and zip across country at full speed. some 500 feet per second. At this speed anti-aircraft fire finds them a very difficult target, and they have approached, passed, and gone before interceptor planes can leave the ground.

The two bombs carried by each plane are both dropped at one time, some distance from the target to allow for the tendency to ricochet along the ground in the direction of the plane's flight. Before their bombs explode, the bombers are already away—and no longer bombers. With their loads discharged, these dual-personality aircraft become fighters with all the speed and maneuverability for which the Hurricane is famous, capable of dealing with any interceptor planes.

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TRACTORS—Not more than 22 percent of all farms in the United States have tractors, but about 66 percent of all farms of more than 100 acres have them.

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PARTS CONTAINER

Plastic Unit Holds Parts Visibly in Compartments

ORIGINALLY designed for holding fishermen's flies and bugs, small transparent boxes have found an even wider application in industrial and other uses where they are employed for holding small parts. Made of plastic, they are available with a variety of compartment shapes so as to be applicable to various types of parts.

Small parts can't hide

These transparent plastic boxes, made by the Shoe Form Company, make it easy to check stocks of parts without opening the box and, since the partitions also are transparent, there are no dark corners where small screws and parts can get lost.

FLUORESCENT LAMPS

Now Available in Small Sizes

TWO new sizes recently added to Hygrade Sylvania Corporation's fluorescent lamp line are the six-watt and eight-watt lamps. These small members of the fluorescent family are designed for supplementary lighting purposes; for example, for instrument panels, in counter lighting, and over machinery. They are also suited for use in bed lamps, pin-up lamps, desk lamps, and for artistic direct or indirect illumination of mirrors, pictures, walls, and so on. The six-watt lamp is nine inches long and the eight-watt lamp is twelve inches long. Both are $\frac{5}{8}$ of an inch in diameter. They are made in two colors —3500° white, and daylight—and have an average rated life of 750 hours.

Six watts, eight watts

CELLOPHANE BAGS

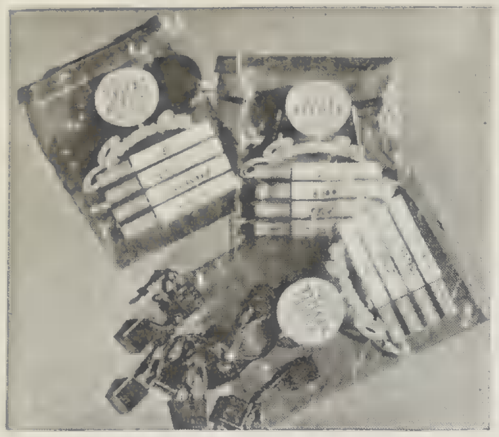
Find Uses in Varied Industries

THE famous Warner & Swasey lathes, now in great demand for armament work, come down the assembly line just a little smoother and faster because of Cellophane bags. All smaller parts are tagged with a part number in the stock room, then loaded into Dobeckmun Cellophane bags. This keeps them intact, yet fully visible to the operator, who does not have to open several containers before he locates the right one.

Since there are between 5000 and 9000 individual parts in a turret lathe, a good job of housekeeping and of control is needed to assure delivery to the assembly floor of all the parts when called for. The transparent bag system has been in effect nearly a year and, according to Warner & Swasey officials, is working out very satisfactorily.

Another use for similar bags, this time with printed panels on the bag faces, has been found by the Leece-Neville Company for the packaging of repair parts. Some fifty different automotive parts are packed in these bags. The white panel on the face of the bag is printed with a special ink which permits easy marking with pencil, crayon, or rubber stamp.

When a bag is packed, the count, part number, and customer's order number is written on the bag. This,



Transparent bags, easily labeled

plus the transparency of the Cellophane simplifies "checking in" the order when delivered to the customer. It also simplifies inventory and reordering as the contents of each bag can be checked without opening the bags or removing the parts.

STEELS

Developed in Peace, Used in War

MANY special steels originally produced by the steel industry for everyday, peace-time uses such as automobile bumpers, carpenters' hammers, and piano strings, are now being used in large tonnages in the manufacture of machine guns, tanks, armor-piercing bullets, other implements of defense.

Because the steel industry long ago learned how to make those steels well and in large quantities, it was able immediately to adapt its experience to the urgent needs of the national defense program.

Among the many commercial steels now serving for defense is an alloy steel containing about 1.5 percent nickel and somewhat less than 1 percent chromium. Developed originally as a steel for axle shafts of heavy-duty trucks, today it is used in the tread mechanisms of tanks where service conditions are even more rigorous than in trucks.

Another alloy steel with about 1 percent chromium and 0.1 percent vanadium, is found in almost every home workshop in the country in the form of a hammer or some other hand tool. It is also to be found today as the steel from which the cocking lever pin of a machine gun is made.

A plain carbon steel containing about 0.8 percent carbon, has long been used by automobile manufacturers for the manufacture of bumpers. A springy steel, it can stand a lot of punishment before crumpling up or breaking. Those same qualities are useful today in the locking mechanism of machine guns. Another important part of machine guns is the firing mechanism which is actuated by a steel spring made from exactly the same kind of wire that is used to make piano strings.

In adapting these and other steels from commercial to defense applications, steel metallurgists frequently prescribe changes in heat treatment and fabrication procedures. These changes are ordinarily made to produce physical properties different from those usually found in the steels.

Basically, however, a large number of the steels which today are building defense material are the same as those from which are made automobiles, pianos, bridges, washing machines, and the multitude of other peace-time products of American industry. — *Steel Facts.*

NITROGEN WELL

Discovered While Drilling for Water

PURE nitrogen gas flows from a recently drilled shallow well on a western ranch, Harold Cook, consulting geologist of Agate, Nebraska, reports in *Science*. This is believed to be the first nitrogen well ever struck. The well was being drilled for water, Mr. Cook says, when it began to yield gas at a considerable pressure at a depth of only 156 feet. A sample sent to the laboratory of the United States Geological Survey for analysis was found to be composed of 100 percent nitrogen.

Since an apparently large supply of pure nitrogen, all ready to use, may have value in the present war emergency, the new-found well has been shut down to conserve the gas until the best possible uses are developed.

FULGURITES

Made Artificially, Using "Hot" Lightning

ENGINEERS at the Westinghouse high-voltage laboratory recently caught man-made lightning in a bucket of sand to produce replicas of the glass-like fulgurites formed by natural lightning strokes. "Since a temperature of about 3000 degrees is required to melt sand into fulgurites, these experiments give us definite knowledge of the tremendous heat which lightning can produce," Dr. P. L. Bellaschi, directing the experiments, reported.

"Fulgurites might be called petrified lightning," the investigator explained, "since they have the same crooked shape as the bolts that formed them. Natural specimens occasionally are found buried in the ground, particularly in dry desert sands. They are glass-like tubes of solidified sand, formed when lightning surges through dry earth in search of moist ground to neutralize its charge."

Because of the scarcity of natural fulgurites, the Westinghouse lightning engineers have shipped their first col-

Man imitates nature

lection of artificial specimens to the Chicago Museum of Science and Industry and are now preparing a second collection for the Franklin Institute in Philadelphia.

"Natural fulgurites are discovered rarely, because conditions must be just right for their formation," continued Dr. Bellaschi. "The sand must be of the proper composition to melt into the glass-like formation. And it must be struck with 'hot' lightning—a type that lasts longer than average strokes. Only a small percentage of the strokes is of this hot variety. Also, since fulgurites are concealed in the ground, they are discovered only by accident."

In the manufacture of artificial fulgurites Dr. Bellaschi used pure quartz sand, plus a small amount of feldspar sand to make the quartz melt more easily. The sand was packed firmly into a container about two feet tall and the end of an electric conductor from the "lightning maker" was stuck into the sand.

Then the generator was set to deliver a hot lightning discharge of 1000 amperes. In a hundredth of a second the artificial stroke bored its own path through the sand and heated the walls of this hole white hot, forming the fulgurite.

"A hundredth of a second is a long time for a lightning stroke to last," the investigator commented. "Some of nature's bolts, as well as those produced in our laboratory, last only a few millionths of a second. Such short strokes are known as 'cold' lightning, since they do not last long enough to create great heat in the substances through which they pass. However, they do ex-

ert explosive forces, shattering telephone poles and trees, blowing earth into the air, and causing thunder.

"Since it lacks the explosive force of cold lightning, hot lightning does not cause thunder. It destroys quietly. Strokes of hot lightning sometimes last as long as a tenth of a second—long enough to set fire to wooden structures or melt sand, rock or power wires. Many natural lightning bolts have both hot and cold elements, and therefore can start fires as well as cause thunder."

PROTECTION

Liquid Coating For Brickwork, Metals

Designed for use on exposed surfaces in furnaces, kilns, incinerators, cupolas, and so on, a new liquid material available under the name of Helfyre can be painted over the surfaces of refractories as well as metals. The resulting coating protects against attack by slag, acids, and corroding elements at temperatures up to 3200 degrees, Fahrenheit.

SAWDUST

Serves as Fuel in Home Furnace

With new installations of gas-heating equipment prohibited, possible priorities on additional equipment for the use of fuel oil, and transportation facilities needed for the moving of war materials proper, it may be that Eastern and Southern house-holders, as well as those in the West, will soon be looking to America's abundant forests as a source of residential heat.

This would be no news to thousands of western home owners who live in the vicinity of the forest products mills.

Hopper-fed sawdust burner

For years chipped wood, mixed with sawdust, has been an important source of home heat in Tacoma, Seattle, Portland, and many other cities of Washington, California, Oregon, and Idaho. In fact, 25 percent of Seattle homes use such heating systems. The idea is applicable to other parts of the country because America's vast forest resources are scattered throughout the nation, and, for fuel, as well as in countless other categories, these resources can pinch-hit for war-scarce commodities.

Chipped wood and sawdust have proved to be a practical source of home heat, an economical fuel, and one which presents no fire hazard since sawdust is naturally damp. In the type of burner shown in one of our illustrations, the sawdust and chips drop from the bottom of a cone-shaped hopper into a burning grate designed for installation in an ordinary furnace. A hopper of sawdust will burn about 12 hours under normal conditions and provide plenty of heat with practically no ash.

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FINE YARN—A type of yarn produced on ordinary textile machinery for making typewriter ribbons, airplane fabrics, and fine dress goods, is so fine that it takes 50 miles of it to make one pound.

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PAGING SYSTEM

Can Also be Used for Private Conversations

Private two-way conversations between any two or more points, conventional paging through loud speakers, or telephonic conferences can be had by the use of a new paging system recently placed on the market by Executone, Inc.

Each station of the system comprises a hand-set telephone and a loud speaker; any number of assemblies between two and 70 can be installed in any one system. The stations are connected through a branch to a six-conductor cable leading to an amplifier connected to any 110-volt A.C. source.

In operation, a call is made from any station, the caller merely talking into the mouth piece of the hand-set while holding the paging button depressed. The name of the party being called thus issues from the loud speakers at all stations, and in addition, a signal light shows at each hand-set box. To answer, the person called lifts the hand-set at the nearest station and private two-way conversation is established.

Answering a call on paging system

All loudspeakers are then automatically silenced.

For conference work, the person calling a conference pages the names of all men with whom he wishes to confer. These men then go to the nearest station, remove their respective hand-sets, and all stations are interconnected for conference work.

In addition to these uses, this system is being applied to broadcasting general messages to all departments.

ARMOR-CRASHING

Bullets X-Rayed by High-Speed Tubes

First X-ray pictures of bullets as they crash through steel armor-plate are being taken by Army laboratory technicians at Frankford Arsenal. Twin X-ray units, each capable of delivering a charge of 300,000 volts in a microsecond (a millionth of a second) will be used for a series of Army studies of the action of bullets in flight within gun barrels and when they hit targets of armor plate or other materials. This research will be directed by Lt. Col. L. S. Fletcher, officer in charge of Frankford Arsenal Laboratory.

Although a bullet travels at $2\frac{1}{2}$ times the speed of sound, the new X-ray photographic technique, developed in Westinghouse research laboratories, permits making two separate exposures during the flight of a single bullet. The two X-ray machines stand side by side, and the elapsed time between the two exposures can be varied from a five hundredth of a second to a millionth of a second. Two exposures can also be made simultaneously.

In the new ultra high-speed X-ray machine a series of six condensers and a power transformer are used. Drawing power from an ordinary 220-volt line, the condensers act as reservoirs, storing up electricity for nearly a minute. When the condensers are charged to a limit set by central controls, they send a jolt of 2000 amperes at approximately 300,000 volts to the X-ray tube. In the tube this energy is converted first into electrons and then a fraction of it to a tremendous surge of X-radiation which does its work in one-millionth of a second—almost as long as it takes a car, traveling at 60 miles an hour, to move a distance equal to a quarter of the thickness of a sheet of writing paper. An intricate timing device enables operators to fire the two machines quickly enough to get two exposures of a bullet before it has moved more than a few feet.

The first experimental tube which made possible ultra high-speed X-rays was developed in the Westinghouse Lamp Laboratories at Bloomfield, New Jersey, by Dr. Charles M. Slack and his associates. This tube generated the X-ray-producing electrons successfully for the first time without the aid of the usual heated filament. In tubes whose elements heat to produce electrons, speed of an exposure is limited to about one-hundredth of a second because the

power required to make any faster pictures would burn out the inner mechanism. The "cold cathode" principle removes the limit on the amperage that can be applied and hence can produce an enormously greater amount of X-rays.

STRESSED SHEETS

Of Steel Used in New Structural Units

By pulling steel sheets into tension between framing members and fastening them together without riveting or welding, a new method of structural construction has been achieved. This type of assembly, known as Lindsay Structure, is claimed to possess tremendous strength and to abolish needless weight. It is a definite breakaway from the traditional methods of steel construction and promises an annual saving of more than 100,000 tons of steel by using light sheet for many types of construction ordinarily requiring much heavier metal.

Sheet metal has been used for years on light structures—but simply as a covering material. Ordinarily, all initial racking stresses to which a structure is subjected are borne by the framing, which must be crossbraced to withstand them. If the framing begins to "wear," these stresses are concentrated at the weakest point of the sheets—the rivet, the bolt, the screw holes, or the tightest point of the weld.

In Lindsay Structure the sheets are pulled into tension between the framing members. These "pre-tensed" sheets instantly resist any movement of the framing, and the load is distributed over the entire area. With this construction, therefore, it is possible to use lighter-gage sheets and lighter framing, usually with a marked increase in strength.

This method of construction eliminates crossbraces, gussets, and struts by placing the sheets under tension between the framing members; it creates a union between sheets and framing

Stressed steel structure—strong

that approximates the full strength of the sheet; and it provides ease in assembly and disassembly from the outside, equivalent to the simplest bolted construction.

Many types of mobile structures have been fabricated with this new method. Motor truck bodies, bus bodies, railroad cars, and marine superstructures are some of the applications where light weight, tremendous strength, and rigidity are of primary importance. The system has also been used successfully in the construction of machine housings, industrial buildings, refrigerator lockers, farm buildings, portable shacks, garages, and other structures of diverse uses.

GOLF BALLS

To Be Recovered for Further Use

A METHOD for re-processing used golf balls, developed to meet the war-time emergency, was announced recently by United States Rubber Company. Golfers are therefore urged to save their used balls.

It is claimed that the re-processed balls will look like new, except that they will be branded to indicate that they have been re-processed. They will have good playing qualities and will give service almost equal to new balls. The re-processing will be accomplished without using any materials on the restricted list.

When balls are received for re-processing, they will be inspected and those balls which are out of shape, too old or too badly cut, will be discarded. The balls will be classified according to construction, the old covers removed, and new covers will be molded on the balls.

The cover will be of Tjipetir, a special form of Balata, and the new cover will be identical to the covers of new balls. The re-processed ball will then be finished, painted, and marked with its proper brand name, depending on its construction.

Only the company's own brands will be re-processed by this method. Individuals are asked not to send balls to the company direct, because no provision will be made for this service direct to consumer. When the plan is put into effect, players will be asked to turn in their used balls to their golf professionals. They will receive a merchandise credit which they may apply either to the purchase of new balls, as long as new balls are available, or the purchase of "Re-Processed" balls. The pros will return the used balls to the company as sizeable lots are accumulated.

SUGAR

Shortage Has Its Good Health Points

Most Americans have too sharp a sweet tooth, and a little sugar rationing will do them more good than harm, according to diet authorities. M. L. Wilson, assistant director of nutrition, of the health and welfare defense program at Washington, for example, declares: "Sugar rationing certainly will harm no one. People will meet the restriction on sugar by adding calories from other sources—sources which contain vitamins and minerals lacking in our refined sugar."

Dr. L. H. Newburgh, University of Michigan authority on diet, advises: "Don't complain about sugar rationing; it will be good for you. As a matter of fact, it would be a Godsend if there were no sugar at all. For, if there weren't we would be forced to eat more grains, meats, milk, green vegetables, and other foods which give us everything that sugar does, plus much-needed B vitamins and minerals."

Dr. Newburgh points out that sugar's only importance to our diets is its fuel value, and this may be readily replaced by a host of other foods which provide more than mere fuel. Milk is the best fuel substitute for sugar, since it also provides proteins, vitamins, salts, and fats. One glass of milk, he says, is equal in fuel content to four teaspoonfuls of sugar.

Whole cereals are a much more wholesome food than sugar, since they provide, in addition to fuel, vitamins of the important B group and 10 percent of protein. An ordinary portion of oatmeal, for example, is equal in fuel value to four teaspoonfuls of sugar. Perhaps those who "have always intended to cut out sweets" will find the push from Uncle Sam helpful—*Science Service.*

BEWARE OF CADMIUM

Not Safe for Use in Food Containers

Evidence of a public-health hazard in the use of cadmium for plating food containers and food processing equipment, says the United States Department of Agriculture, adds interest to results of tests made some time ago by scientists of the Bureau of Agricultural Chemistry and Engineering and Stanford University.

Any cadmium-plated article coming in contact with food, particularly food with an acid reaction, reported the investigators—Wilson, DeEds and Cox—is likely to contaminate the food and to cause acute illness. Small quantities of cadmium taken in daily, the investigators reported, can produce anemia, enlargement of the heart, and bleaching of tooth enamel—a bleaching similar to the effect of fluorides.

Since efforts are being made to meet shortages of various materials, research of this kind is of high importance in insuring the public safe and sound substitutes. Cadmium is already branded as unsuitable as a plating substitute for containers or for food handling equipment.

ARTHRITIS

Linked to Childhood Rheumatic Fever

Evidence that chronic infectious arthritis in adults may have resulted from rheumatic fever in childhood is given by Dr. Archie H. Baggenstoss and Dr. Edward F. Rosenberg of the Mayo Clinic, according to *Science Service.*

The two Mayo physicians feel that arthritis involves more than disease of the joints; that it involves the vital organs, the crippled joints being merely one expression of this malady.

They examined the organs of 30 patients who had had chronic infectious arthritis and found evidence of disease in the heart, kidneys, liver, and other organs. There was damage to the heart in 24 cases and in 16 of these the injury was indistinguishable from that caused by rheumatic fever. Also significant was the pathologic condition discovered in the kidneys. It was felt that heart and kidney damage was due to the same underlying set of causes.

Drs. Baggenstoss and Rosenberg concluded there may be a relationship between chronic infectious arthritis and rheumatic fever, typically a disease of childhood.

SAFE PORK

Insured By Storage At Low Temperatures

Trichinae which cause the serious disease trichinosis, will not survive in pork treated by adequate freezing, according to the United States Department of Agriculture. The thickness of the cuts of pork or the inside dimension of the container determines the length of time the meat must be subjected to a given temperature to destroy any trichinae that may be present.

Pieces of pork or pork products not exceeding six inches in thickness must be stored for a continuous period of not

less than 20 days at a temperature not higher than 5 degrees, Fahrenheit, or not less than 10 days at —10 degrees, Fahrenheit, or not less than six days at —20 degrees, Fahrenheit, to assure complete protection. For larger pieces or packages up to 27 inches in thickness, the storage period is doubled, except in the case of 5 degrees when the period is increased to 30 days.

The Bureau warns that in many food locker plants, temperatures are not kept low enough to insure a complete kill in stored pork.

GERM-KILLING

By Ultra-Violet Light Has Great Possibilities

RAPID increase of air sterilization by ultra-violet light to include apartments, offices, private homes, military mess halls, barracks, and hospitals was predicted recently by Dr. Theodore S. Wilder. He pointed out that "curtains" of the invisible artificial sun rays have successfully lessened the occurrence of measles in selected Philadelphia schools, and infections following surgery in hospital operating rooms, reports *Science Service*.

Ultra-violet light, the part of the sun's rays which causes sunburn, is fatal to bacteria and apparently to the viruses, germs so small they cannot be seen under a microscope.

In apartments with air conditioning the ultra-violet light would be especially valuable, Dr. Wilder said, since "recirculated air has been proved to be a carrier of contagion. It may not be far fetched to hear a Mr. A complain that his invaluable secretary is laid up with grippe which he is sure she caught from his friend Mr. B 10 floors above him."

Private homes might provide ultra-violet sterilization for the nursery, particularly where the infant has just come from a sterile hospital nursery. Further, ultra-violet light might take the place of the sheet, soaked in antiseptic, which used to be hung across the door of the sick room.

Military hospitals, dispensaries, barracks, lavatories, mess halls, and recreation rooms might find ultra-violet protection especially valuable during winter and early spring in cold climates. Dr. Wilder warned, however, that "the mere presence of an ultra-violet source in a given room is no guarantee that it is accomplishing anything. Varying air currents and reflecting surfaces greatly alter the efficiency of the light," and he added that the need of a particular situation for ultra-violet light should be determined by physicians, and its installation made by experts.

Industrial Growth

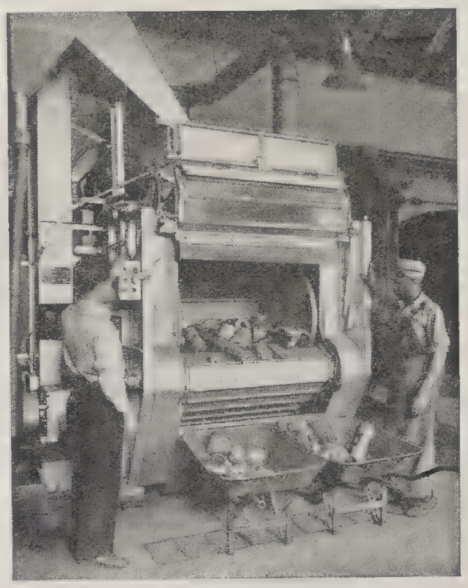
New Products and Processes That Reflect Applications of Research to Industrial Production

CLEAN?

Simple Test for Metal Parts

For blemish-free metal finishing—enameling, plating, galvanizing, tinning, and so on—it is imperative that the product be chemically clean—free of *all* foreign material.

Although these parts may look clean as they come from the cleaning room, it is entirely possible that traces of sand, scale, or other extraneous material may still be adhering. When that happens rejects in the finishing room become a certainty, with a consequent waste and loss of production.



Cleanliness test via open door

The simplest of all tests on iron castings, forgings, sheet steel (except stainless), and so on, is to make a saturated solution of copper sulfate (blue vitriol) to which a slight amount of sulfuric acid (2 percent) has been added. The use of this solution serves to detect the presence of iron in any form, including its alloys, by forming a bright yellow copper coating on the surface of the article tested.

Where sand, iron oxide, or foreign material is present, the surface will remain in its original color or may be blackened.

The material suspected of being chemically unclean can be tested either by immersion in the solution or by rubbing the solution on the work with a swab, such as the type used for throat painting. Special emphasis should be given to the fillets and cavities in the piece, if enameling or plating is to follow. It is a good idea to renew the solution or redip swab for each test.

For abrasive blast cleaning, it is a simple matter to determine when all pieces of a load in a Wheelabrator Tumblast are evenly cleaned, because all the operator has to do is stop the abrasive blast, open the machine door and conduct the test on a few selected pieces. Should additional cleaning then be necessary, the door can be quickly closed and the blasting resumed for as long as is required to remove whatever objectionable material may be present.

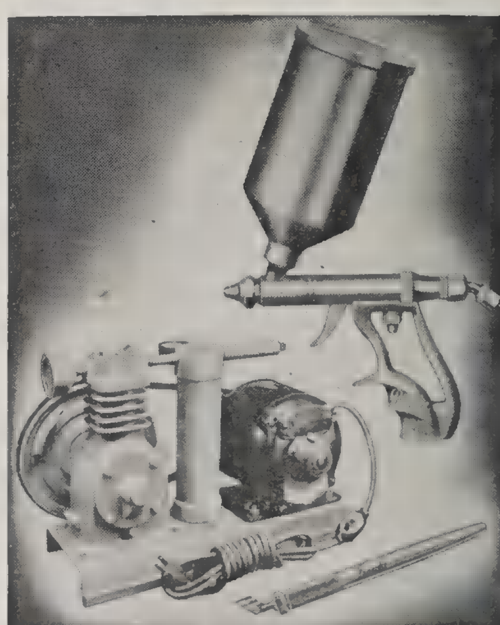
SAND BLASTING

Equipment For Design Cutting, Paint Removal

A light-weight sand blasting gun, equipped with a gravity-fed reservoir with a capacity of ½ pint, is now available for cutting designs in plastics, stone, glass, and so on. The same unit is also suitable for cleaning paint from small areas and for sand blasting small castings.

One of our photographs shows the complete sand blasting outfit including a portable compressor with a driving motor; the gun itself can also be operated on any compressed air source.

Abrasive from the reservoir is fed to a hardened-steel nozzle and is de-



Complete, ready for use

livered in the air stream when the trigger is pulled. The gun and its portable air supply source is manufactured by Paasche Airbrush Company.

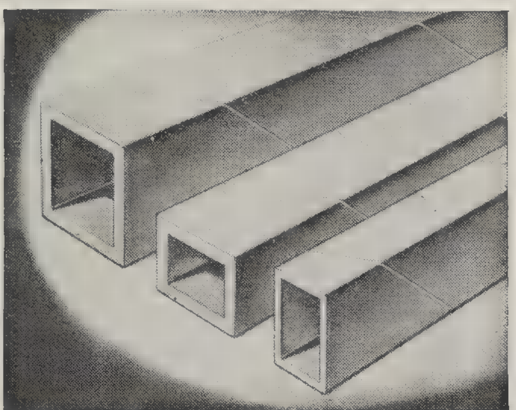
PAPER TUBES

Manufactured With Precision Tolerances

PAPER tubes for electric coils, produced by the use of a specially adapted heat die machine, are now being made to precision specifications.

Heavy compression insures strength and resistance to collapse, accuracy in sizing, superior dielectric properties, lower moisture absorption rate, square corners, and straight side walls.

The improved tubes, produced by Precision Paper Tube Company, are preliminarily formed of dielectric kraft or fish paper, or a combination of both.



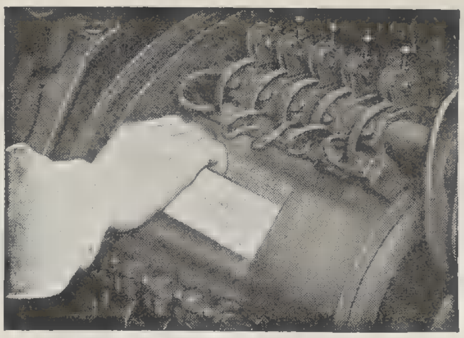
Also in rounds and ovals

The paper is spirally wound on a steel die in an automatic machine. The tube is then pushed pneumatically through the new heated compression die which effects an added compression of about 10 percent. Tubes made by this process can be obtained in round, oval, square, or rectangular cross section and in continuous lengths of any wall thickness with any inside or outside diameter. Tolerances are held to 0.002 of an inch.

COMMUTATORS

Kept Clean With Non-Clogging Stone

EXCESS film and dirt caused by heavy, continuous power loads on motors can be easily and quickly removed from commutators with a new cleaning stone announced by the Ideal Commutator Dresser Company. The stone cleans while the motor or generator is running. It is used by simply holding it against the commutator and slowly moving it across the face. The stone does not clog, nor cut the commutator. It also cleans film from the brush seats and helps to re-seat brushes.



Clean commutators serve best

So called "excess color," "skin" or "film" resulting from oxidation around paper mills, chemical plants, printing departments, Diesel locomotive generators, and so on, are all removed—only the "electric film" remains on the commutator assuring perfect commutation. Regular cleaning of commutators will help in keeping motors and generators on the job 24 hours a day. Only a clean commutator can be expected to function properly, with reduced noise, uniform brush wear and minimum chattering and sparking.

NO SLIPPING

When Floors Are Covered With New Powder

TO provide traction on floors near machines, work benches, and other areas that tend to become slippery, a material in powder form has recently been put on the market by Theo. B. Robertson Products Company. The powder not only prevents slipping but absorbs oil and grease and is swept up and replaced when it becomes dirty and saturated.

OIL REMOVAL

From Metal Surfaces With Special Liquid

AN industrial cleaning material for use in washing machines quickly removes heavy coatings of mineral oil from metal surfaces and leaves a rust-preventing film. This liquid, manufactured by Quaker Chemical Products, is used in the proportion of one gallon with 25 to 75 gallons of water and the resulting solution is maintained at a temperature of 130 to 175 degrees, Fahrenheit. It is claimed that the solution will not attack metals and that there is no danger of fire or explosion through its use.

The oil that is removed by the action of the solution floats to the top and can be skimmed off. Thus the only solution which is lost and requires replacement is that which is removed from the machine on the washed metal parts.

Post-War Possibilities

Extensive Growth Forecast in Employment, in Both Manufacturing and Service Branches of Aviation

ALEXANDER KLEMIN

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STUDENTS at several universities have written us for information on post-war aviation, a subject which seems to be providing the colleges with possibilities for theses. We have been loath to venture into the realms of prophecy. A *Fortune* Magazine Round Table has been much bolder. If E. R. Breech, Board Chairman of North American Aviation; E. P. Warner, of the Civil Aeronautics Board; and Frederick C. Crawford, President of Thompson Products—certainly authorities on the subject—are to be believed, the outlook for post-war aviation is an excellent one.

Even if we achieve a complete victory over the Axis, there would be needed 24,000 military planes to police the world—since this time we would not allow our present enemies to get into further deadly mischief. The maintenance and ultimate replacement of these planes would, in itself, provide employment for 100,000 workers. Mr. Breech thought that the volume of private planes might reach 10 to 15 percent of the automobile industry's volume in five to ten years, but could not take up the slack in employment for the four or five hundred thousand men now employed in aviation. Mr. Crawford was much more optimistic. "People have not yet become accustomed to this convenience. We have not seen anything yet. I think air transportation of perishable goods is coming. People have no conception of the land crews that will be necessary. We will have more people servicing and repairing and building and flying planes and selling tickets . . . "

Mr. Warner was still more encouraging, though he quite rightly pointed out that it was not price (that is, low price) which would make aviation generally acceptable, but the more complete solution of the problems of aviation. We must solve weather limitations, provide innumerable airports. The unparalleled efficiency of the airplane was stressed by the eminent speaker. "So far as I know," said the Vice-Chairman of the Civil Aeronautics Board, "no vehicle on land or sea in surface transportation has ever yet operated on a basis of normal service per vehicle of more than 80,000 miles a year. However with the airplane 500,000 miles a year is common."

Another interesting thought was that the instruments or devices invented during the war for locating enemy aircraft might be utilized for commercial aircraft and enable them to keep out of one another's way in the foggiest weather.

Predicting an enormous growth in the carrying of passengers by air, Mr. Warner said that the annual operating cost for lines operating within the United States might be between six hundred and eight hundred millions a year.

AIRPORT CAPACITY

Imposes New Problems on Air Transportation

AIR traffic has reached such proportions as to raise the question of traffic saturation at major airports. During the last Labor Day week-end, La Guardia Field, New York City, handled 1364 airplanes between Thursday midnight and Monday midnight. With the normal distribution of air traffic that prevails at La Guardia this meant that one airplane was handled every two minutes—close to the utmost capacity of the airport. This was in good weather. Bad weather, even with instruments and blind-landing guides, inevitably cuts down the capacity of an airport. So already the capacity of La Guardia may be said to be approaching its limit. A. F. Bonnalie, of United Air Lines, discussed the problem in very thorough fashion at the recent Airport Conference held under the auspices of the Illinois Institute of Technology. How is this situation going to be met, particularly when the present emergency ceases and more equipment is released to our air-transport companies?

Two definite schools of thought exist in regard to future provisions for metropolitan carrier terminals. One school, so Mr. Bonnalie tells us, adheres to the principle of a multiplication of fields at major traffic centers as the only solution of the problem. This is the simplest solution available, but it is subject to the same difficulties as are multiple station facilities for railroads, with their confusion for the traveler and the prob-

lems of transhipment from station to station. The second school of thought (to which we think Mr. Bonnalie himself belongs) believes that air carriers can best serve the public from one metropolitan air field.

To serve the public in this fashion, without prohibitive size of the landing area, much thought will have to be given to the spreading out of the traffic throughout the day, and to the design of the airport facilities. Duplicate runways will have to be made available for take-off and landing. Triple runways might have to be provided. The taxi-ways would be arranged for one-way traffic. Hangar facilities and terminal buildings would have to provide sufficient frontage to handle a large volume of traffic quickly.

It is gratifying to see that the problem of airport capacity has already arisen. It will be solved by ingenuity and feeling for organization.—*A. K.*

DYNAMOMETER

Combination Unit Absorbs Full Engine Power

As aircraft engines increase in size, so do dynamometers; these are now being built by the score in sizes up to 4000 horsepower and some are being considered which will be even larger.

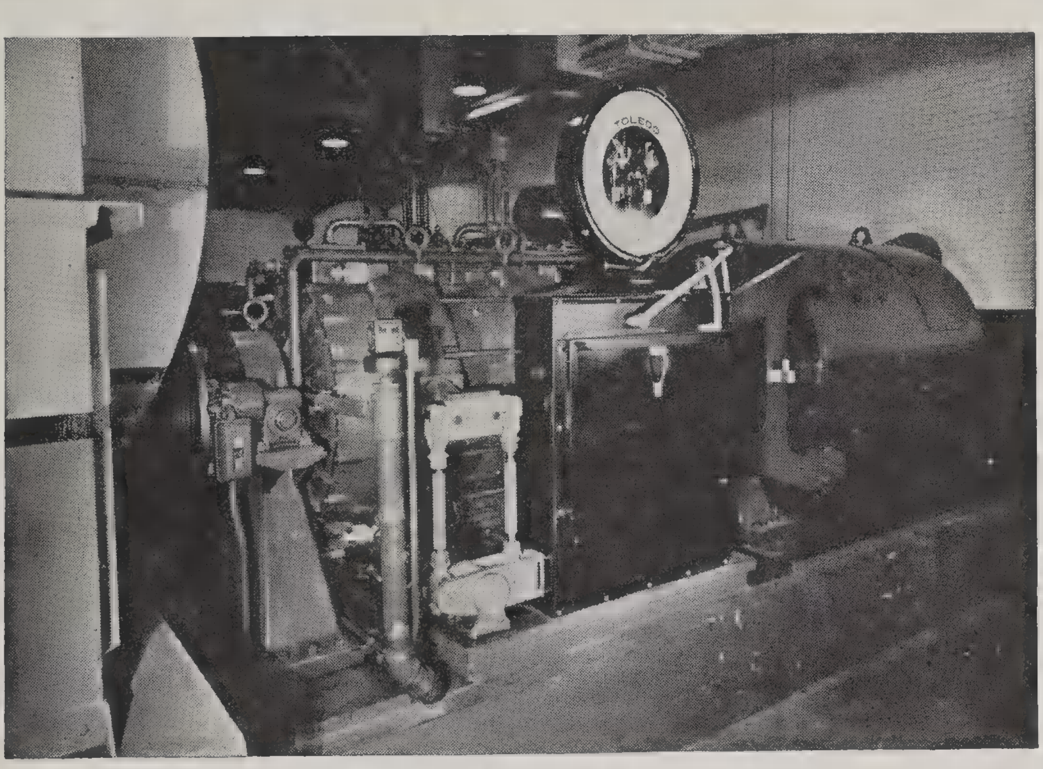
The Westinghouse dynamometers, installed by Detroit engine manufacturers, are representative of these testing installations. In one of our photographs the airplane engine is out of the picture behind the wall at the left. From it there extends, through a flexible coupling, a shaft which drives an eddy-current generator capable of absorbing 2000 horsepower and a D.C. generator that can absorb 750 horsepower. The frames of both are cradled so their tendency to turn can be measured on a set of scales. The energy absorbed by the eddy-current generator is carried off as heat; that developed by the D.C. machine is returned to the power lines through a motor-generator set. This combination dynamometer can absorb the full power of the airplane engine at any speed up to 2000 rpm.—*A. K.*

PRONE FLYING

Has Advantages for Military Purposes

In a recent issue of "The Army and Navy Journal," it is stated that both the United States and Britain as well as Germany have for some time been experimenting with pursuit planes for prone flying. The new Fokker Wulfe fighter plane, developed in Germany and still in the experimental stage, is designed so that the pilot and two-man crew all lie prone instead of sitting upright as in conventional ships.

Prone flying, first of all, tends to decrease the cross section of the fuselage and thus provides less drag and more speed. But it has even more value in decreasing the "blackout" often suffered by combat pilots today. In conventional planes, where the pilot sits upright, the centrifugal force developed when coming out of a dive is virtually perpendicular to the pilot's body and the blood drains readily from the pilot's head. In prone flying, the centrifugal force is almost horizontal to the pilot's body. This tends to reduce "blackouts"; consequently the pilot can make tighter pullouts and spirals. In dive bombing this permits delayed pullouts.—*A. K.*



Soaks up power, records it accurately

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Tone Separation

DARK tones against dark areas, light tones against light, bring a loss in the clarity of detail due to semi-absorption of the detail by the background. Unwittingly, however, some workers frequently find themselves faced with such a problem as that shown in the illustration, where the dark boat model is almost lost in the dark-toned shirt worn by the boy. An excellent picture, made, incidentally, by Robert Toran, of New York City, the print has good composition, good human interest, a fine expression on the boy's face. The lack of tone separation between the boat and the shirt is the only jarring note. A lighter shirt or side or back lighting for the boat would have done the trick and made a good picture better.

Tone separation could be better

Tabletop Trees

ERNEST E. DRAPER, who is frequently referred to as America's tabletopper No. 1 because of the remarkable realism he succeeds in injecting into his pictures, invariably uses the small locust tree to simulate reality. With roads, mountains, houses, and so on, scaled to the tree, and employing a low viewpoint for the camera, the tree looks as real as life, as indeed it is, lending authenticity to the entire scene. Mr. Draper finds the tiny trees in empty lots and other abandoned places, and thinks it is ideally suited to tabletop use.

Kodachrome or Kodacolor

NOW that we have them both, which shall we use? First, it is a matter of camera equipment. If you have a 35mm camera only, you are limited to Kodachrome, since Kodacolor is not available in that size. However, if you have a 35mm as well as a larger roll-film camera, and there is a choice, we would say offhand that the pictures you take on Kodacolor will be those you will want to give to friends or place in an album, while Kodachromes will be used for scenery, flower studies, and similar subjects. Another aspect to consider is the comparative speed of the two materials, Kodachrome being rated Weston 8 and Kodacolor Weston 20. The two mediums may, therefore, be used in somewhat the same manner as slower and faster black-and-white film is employed, suiting the medium to the requirements of the situation. Where Kodachrome is too slow, for example, for a required snapshot exposure, Kodacolor may do the job very well.

Filmo Moviquiz

THE quiz craze has now been introduced by Bell & Howell in the 16mm rental film field in the form of the "Moviquiz." Explaining how the game works, the company says:

"The participant, student at school or guest at a party, is given a printed sheet of questions, and is asked to indicate the answers in the spaces provided. A film is then shown, in which the correct answers are found, and from then on, the grading of papers, rewriting of answers, or paying of 'forfeits,' is up to the teacher or host, as the case may be."

There is a choice of several series of new, one-reel films, for each of which a "Moviquiz Kit" is provided. This kit contains a set of question sheets, a master list of correct answers, and suggested methods of scoring.

How Do You Hold Your Camera?

EVERY worker has his own particular argument for the way he holds his camera, but the next fellow may present just as strong a brief for some utterly different method that happens to suit him. Both are

Convenience comes first

right because the method adopted by each worker is the best for him. It's just a matter of habit and convenience. The chap in the illustration finds the method shown especially helpful because of the way the Kalart synchronizer unit is attached. Turning the camera upside down gets the picture just the same and, for this photographer, with greater comfort.

Panda Bites Photographer

THEY call her Ylla, the famous European photographer of animals, and being rather pretty besides, she got ready permission to enter cages of animals at the Bronx Zoo in New York City, in order to make close-up shots with her twin-lens reflex. She was getting along fine when, one day, she entered the cage of the panda, ordinarily a harmless creature but on this occasion very effusive in her greeting of the lady photographer. Ylla insists even now that the panda was only playing and that the bites and scratches inflicted by the animal were mere tokens of affection. And, to top it all, Ylla is coming back again, explaining that the next time she is going to wear slacks as it appears the panda had taken a fancy to her legs which, the photographer having worn a skirt, were free.

Background of Cobbles

BACKGROUNDS in outdoor photography are frequently a bane to the amateur worker who has been cautioned against setting his subject in front of a cluttered-up scene, with the distracting effect that inevitably results. The usual method, where possible, is to shoot the subject against a sky background by having the camera low or setting the subject on an elevation. Another recommended procedure is to use water as a background; a third, a plain wall. A novel approach to the problem, recently reproduced in a fashion photograph in one of the leading women's magazines, was a figure set against a background of cobblestones. The shot was naturally made from above with the camera tilted down in order to get an over-all pattern of cobbles.

The Smoker

SMOKING a pipe, even when working in the darkroom, is something Robert Bagby likes to do. But ashes have a way of falling out of the bowl when the pipe is tilted a bit. Bagby never has any trouble with this difficulty, however, as he habitually smokes a pipe of the so-called outdoor type, with a hinged perforated hood. Designed for the hunter and sportsman who likes to smoke a pipe outdoors without the disadvantage of having ashes blow into his face, it seems to work as well for the outdoor photographer and indoor darkroom worker.

"Big Brother"

IN the contemporary annals of pictorialism, the name of David Darvas, of Cleveland, Ohio, is coming steadily into a place of leadership. One contributory cause is the reproduced print, "Big Brother,"

"Big Brother"

hung in the recent New York salon of the Pictorial Photographers of America. Mr. Darvas, who is a superb technician as well as a fine camera artist, manages in this print to satisfy both documentarian and pictorialist. We do not know the circumstances surrounding the making of this picture, but Mr. Darvas certainly is to be complimented on his skill and understanding in getting the children to assume such a natural attitude and expression.

Acetate Diffuser

A DIFFUSING material, intended for use by architects as an overlay in making tracings, has been found to be of exceptional value in photography. The material, which has an acetate base, transmits about 75 percent of the light, as compared with only half that or less when using other diffusion materials. Supplied 21 inches wide, the material is available in art stores, being sold by the foot. Because of its generous width, ideal diffusion is provided over a great area.

That Darkroom Sink

HAVING trouble with a leaky wooden sink? Then try this stunt. Get some white lead and a supply of candlewick. Fill in the cracks with the white lead and then stuff the candlewick in liberally. Of course, the sink must be thoroughly dried before these repair operations can be satisfactorily begun.

Ground Glass Manipulation

THE ground glass back on a view camera does not have to remain on the camera while arranging the subject. When trying for different angles, it is rather a cumbersome and time-consuming job to keep moving the camera itself. It is easier and just as effective to remove the ground glass back and hold it at different angles until the subject composition looks right. Then move the camera to the wanted position, and there you are. The camera is moved only once, saving labor, to the position previously determined by manipulation of the free ground glass.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

ANNAPOLIS: GANGWAY TO THE QUARTERDECK

By Captain W. D. Puleston, U.S.N.

In the year 1845 (the year of the founding of Scientific American) there came into being the United States Naval Academy. How this world-renowned institution for the training of naval officers evolved from earlier experiences and controversies regarding training methods and requirements, and how it has developed to its present stage of efficiency and thoroughness is told in the pages of "Annapolis" by a naval officer who is well qualified for the job in hand. Captain Puleston, known to readers of this magazine as a Contributing Editor and for his splendid articles on naval matters, was graduated from Annapolis in 1902. Since then he has had a brilliant and all-embracing career in the Navy. With this background he has welded together the running story of progress in naval training at Annapolis, told as only one can tell it who is imbued with love for and loyalty to the service which has commanded his life-long devotion. The information contained in this latest of Captain Puleston's books will serve to give the reader a greater appreciation of the glorious traditions upon which have been built the United States Navy that is today facing the supreme test on far-flung battle lines. (259 pages, 8½ by 5¾ inches, a number of photographs, glossary of naval slang.)—$3.10 postpaid.—*O. D. M.*

JEWELRY AND ENAMELING

By Greta Pack

Instructor in the Art Department of Case Technical High School, Detroit, gives definite instructions on basic processes and applications—instructions that tell you exactly what to do, seriatim, by definite steps, not simply vague elusive talks about the work. These cover a lot of territory, such as annealing, pickling, soldering, casting, chasing, repousse, modeling, carving, wire working, domes, balls and stamped forms, enameling, stone setting, ring making and so on. (377 pages, 5½ by 8½ inches, 114 illustrations, mostly multiple.)—$2.60 postpaid. —*A. G. I.*

DOCTORS ANONYMOUS

By William McKee German, M.D.

Revealing insight into the role of the pathologist sleuthing out the correct diagnosis of diseases—a romantic side of medicine which is almost unknown to the average layman. This most readable account, by a pathologist who is introduced in a foreword by Paul de Kruif, will make the public more conscious of the importance of choosing hospitals which have well-equipped laboratories for tracing down diseases. No dull reading here! (300 pages, 5½ by 8¼ inches, unillustrated.)—$2.85 postpaid.—*F. B. I.*

MACHINE SHOP WORK

By John T. Shuman

Comprehensive treatise for apprentices and others. Covers not merely the lathe, but fundamental phases of all the major machines and operations: hand tools and their work; drilling machines; lathes; grinders; planers; shapers; milling machines; gearing; broaching; turret lathes. The illustrations are so numerous and clear that the book is suitable for men working alone. It is decidedly on the practical side, and on no other. Author is Co-ordinator in the Williamsport Technical Institute. (499 pages, 5½ by 8 inches, many illustrations.) —$3.60 postpaid.—*A. G. I.*

AUDEL'S MECHANICAL DICTIONARY

Compiled by N. Hawkins, M.E., and E. P. Enderson, E.E.

In scope, this book covers much more ground than is indicated by its title. Actually, the text borders on the encyclopedic, giving not only the correct definitions of words but, in many cases, tables, rules, formulas, recipes and practical hints, helps, and suggestions as well. The book was designed to give a full and correct vocabulary and background of the meanings of words in the world of mechanics; hence practically all non-mechanical matter is excluded. Indicative of the broad coverage, however, is the fact that brief biographies of a number of pioneers in the mechanical and scientific world are included, giving what amounts to a condensed history of mechanical progress. Approximately 17,000 words, terms, and phrases are presented. (918 pages, 5½ by 8 inches, unillustrated.)—$2.10 postpaid.—*A. P. P.*

THE TRISECTION PROBLEM

By Robert C. Yates

Gem of a work—compact, crisp, concise—for two categories of readers: those who believe it possible to trisect the general angle with compasses and unmarked

straightedge alone (the old rule of the game), and those who don't. Main content: solution by mechanisms (graduated ruler, compasses of Hermes, three-bar apparatus, pantograph, carpenter's square, the isoklinostat); approximate methods (six familiar types); quixotic cases (tilting at windmills); and bibliography of 52 most important published sources of other literature on the same problem. This book, by the associate professor of mathematics at Louisiana State University, embodies the mathematician's answer to the would-be trisector, and within two covers rounds up all the chief dependable data on this never-ending dispute. (68 pages, 6 by 9 inches, 43 figures.)—$1.10 postpaid.—*A. G. I.*

THE CONDENSED CHEMICAL DICTIONARY

Edited by Thomas C. Gregory

In its third edition, this inclusive compendium on chemical products is much enlarged and its usefulness expanded by the addition of descriptive data on a large number of compounds and preparations sold under proprietary names. While most of these are only briefly defined, the information about them is valuable to anyone interested. As in previous editions, data on properties, preparation, grades, and uses of chemicals and related materials are given briefly. Tables of useful information occupy 61 pages. The encyclopedic scope of this work makes it an invaluable reference. (756 pages, 6 by 9 inches.)—$12.10 postpaid.—*D. H. K.*

FRESH WATER FISHING

By Myron E. Shoemaker

With a chapter devoted to each important specie of fresh water fish found in north American lakes and streams, descriptions of their habits, guidance as to lures and methods of use, and an interesting history of angling, this book warrants a place in any fisherman's library. Outstanding, too, is the emphasis placed on the relation between the deterioration of our fishing and the wanton destruction and depletion, through ignorance and otherwise, of our natural resources, with a conclusion that restocking of streams will not alone solve the game fish problem. (218 pages, 6 by 9 inches, four color plates and numerous line drawings.)—$3.10 postpaid.—*A. D. R., IV.*

DOCTOR WOOD

By William Seabrook

Brisk, breezy biography of the noted Johns Hopkins physicist, among world scientists outstanding as an experimental physicist, yet always a "big kid," ever full of practical jokes, who, at 72, is still one of science's pet "characters." On the serious side, in addition to first-rank contributions in pure science, most of them abstruse, recorded in 263 published papers, he made numerous discoveries bordering on inventions, for most of which others received main credit because Professor Wood hit on them too soon: the bucket diving rig, the electric thaw for frozen pipes, methods of color photography, ultra-violet and infra-red photography, an electric nose for locating

mercury-vapor leaks, sodium vapor lamp, method for measuring pressures in gun barrels, hydrogen welding torch, so-called "Vienna" method of crime detection. He also invented the fisheye camera, mercury telescope, war-time signal telescope, Wood's glass. On the frivolous side he wrote the famous book of nonsense verse, "How to Tell the Birds from the Flowers," played some 9,356,268 practical jokes (the score still rises), and always was the iconoclastic, stuffed-shirt-hating *enfant terrible* of science. Famous foreign and domestic academies have publicly honored him with dignified degrees, medals galore, chuckled privately over his pranks. This book will make you chuckle, too—especially if you think professors of science wear long pink whiskers and are only half human. (335 pages, 5½ by 8½ inches, 15 illustrations.)—$3.85 postpaid.—*A. G. I.*

UNDER THE SEA-WIND

By Rachel L. Carson

NATURALISTS' picture of ocean life, consisting of descriptive narratives that unfold the life of the shore, the open sea, and the sea bottom. Somewhat romanticized, but scientifically accurate. Author is a biologist on staff of Fish and Wildlife Service. (314 pages, 6 by 8 inches, illustrated.)—$3.10 postpaid.—*A. G. I.*

ENJOYMENT OF SCIENCE

By Jonothan Norton Leonard

FOR those who want to burrow into science but do not know which books to read, this is an excellent guide, since its main feature is a detailed discussion of the outstanding books in each branch—biology, anthropology, entomology, microscopy, geology, astronomy, physics. A sort of master control of reading, to enable the owner to direct his reading intelligently and not hit-or-miss. It is chatty and friendly—as if the author were answering informal questions. (327 pages, 5½ by 8¼ inches, unillustrated.)—$2.60 postpaid.—*A. G. I.*

MINERALS IN NUTRITION

By Zolton T. Wirtschafter, M.D.

COMPACT, semi-popular, semi-scientific monograph on the newer findings with regard to the minerals as an extremely small but all-important factor in the human dietary—comparable in importance with that of the vitamins. Salt, potassium, calcium, magnesium, phosphorous, sulfur, iron, iodine, aluminum, arsenic, manganese, bro,-mine, zinc, copper, cobalt, nickel, selenium, fluorine—all these are in the body and needed in the dietary; without them the vitamins are of but small value. This exposition is popular but leans toward the serious. It also carries extensive bibliographies to special articles in the professional journals. The author is Clinician in Charge of the Diabetic Clinic at Mt. Sinai Hospital, Cleveland, and instructor in medicine at Western Reserve University. He is also visiting physician, of the Department of Medicine, at the Cleveland City Hospital. (175 pages, 5 by 7½ inches, unillustrated.)—$1.85 postpaid.—*A. G. I.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

The History of Combat Airplanes, by Charles G. Grey, is a 158-page unillustrated brochure which deals with the evolution of fighting planes from pre-World War I days to the middle of 1941. The text is non-technical, giving an over-all picture of military aircraft. *Norwich University, Northfield, Vermont.—$1.00.*

Resistance Thermometers is a 30-page pamphlet which gives a comprehensive presentation of the nature, design, performance, and application of a broad range of resistance thermometers in industrial processes, scientific work, refrigeration, air conditioning, and so on. The types of thermometers are illustrated and fully described. Request catalog No. 9004. *The Brown Instrument Company, Wayne & Roberts Avenues, Philadelphia, Pennsylvania.—Gratis.*

The Jones Heavy Duty Hand Tachometer is a four-page leaflet describing an indicating instrument for measuring speed directly in revolutions per minute or feet per minute. *James G. Biddle Company, 1211 Arch Street, Philadelphia, Pennsylvania.—Gratis.*

Refrigerated Welding is a four-page folder which describes the "Frostrode" welding process and the advantages which it offers to industrial welding. *Weltronic Corporation, Frostrode Division, E. Outer Drive, Detroit, Michigan.—Gratis.*

Definitions of Electrical Terms is a 300-page bound volume, thoroughly indexed, presenting for the first time, under one cover, the definitions of the important terms common to all branches of the art as well as those specifically related to each of the various branches. *American Institute of Electrical Engineers, 33 West Thirty-Ninth Street, New York, New York—$1.00 in the U.S.A., $1.25 outside of the U.S.A.*

A Primer on Grinding Wheel Safety is a 24-page illustrated booklet which presents important facts for grinding-wheel operators in brief text and interesting cartoons. *Norton Company, Worcester, Massachusetts.—Gratis.*

20 Model Railroad Projects, by Frank Taylor, is a 120-page illustrated book which gives full and complete details on the construction of various types of model railroad cars, stations, signals, and other accessories for the model railroad hobbyist. Detailed drawings supplement the text. *Kalmbach Publishing Company, Milwaukee, Wisconsin.—$1.00.*

Squeegee Type Pump is a folded circular describing an industrial pump operating on an entirely new principle. It consists of a flexible rubber tube which is alternately squeezed and released in a rocking-squeegee manner so that the liquid or gas is "breathed" into or out of the tube. The pumps are available in capacities ranging from one-half to 50 gallons per minute. *Downington Manufacturing Company, Huber Pump Division, Downingtown, Pennsylvania.—Gratis.*

How Are Balls Made Round? is an eight-page folder which describes in photographs and text the essential processes in the manufacture of highly accurate ball bearings from the original pressing to the gaging of the finished product. *SKF Industries, Front Street and Erie Avenue, Philadelphia, Pennsylvania.—Gratis.*

The Automobile Users' Guide With War-Time Suggestions is a 66-page manual designed to help the public get the most out of its automobiles and to make them last longer by describing how to save gasoline, tires, and repair bills; also how to prolong the life of a car and keep it looking new. *Customers Research Staff, General Motors, Inc., Detroit, Michigan.—Gratis.*

Thermocouple Data Book and Catalog is a 32-page manual for thermocouple users. It lists various types of commercially available thermocouples and accesssories and gives valuable information on their design and use. Bulletin No. S2-3, *Wheelco Instruments Company, Harrison and Peoria Streets, Chicago, Illinois.—Gratis.*

How to Run a Lathe is the 41st edition—128 pages, over 365 illustrations—of this popular book, complete with a number of changes which bring it completely up to date. It covers lathe operation, grinding tools, making measurements, boring, drilling, and so on, plus reference tables. *South Bend Lathe Works, South Bend, Indiana.—25 cents.*

Carboloy Tool Manual is a 32-page thoroughly illustrated bulletin covering such aspects as tool design, application, grinding, brazing, and tool handling. *Carboloy Company, Inc., East 8 Mile Road, Near Van Dyke, Detroit, Michigan.*—Gratis to industrial readers, libraries, technical schools, and colleges. Request this bulletin on your letterhead.

Magic Bottles is a 20-page illustrated booklet describing specifically the uses of compressed gases in aviation for such purposes as fire fighting, oxygen supplies for high altitude flight, and life-saving rafts and vests. *Aviation Division, Walter Kidde & Company, Inc., 140 Cedar Street, New York, New York.—Gratis.*

Fluorescent Accessories is a folder describing a complete line of fluorescent lamp starters, lamp holders, starter sockets, and other devices for use with these increasingly popular light sources. *General Electric Company, Appliance and Merchandise Department, Bridgeport, Connecticut.—Gratis.*

Cascamite Water Projects, by William F. Crosby, is a folded sheet describing plans which are available for the construction of small boats, water skis, aquaplanes, a sailing skiff, and an ice boat. *Casein Company of America, 350 Madison Avenue, New York, New York.—Gratis.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

THAT the equatorial type of mounting for telescopes is superior to the simple alt-azimuth mounting is something which many of us take more or less for granted. The alt-azimuth has two axes, one vertical, the other horizontal, and, in order to make it follow a star across the heavens, the observer must keep moving it in two directions—the "up," or else the "down," direction (altitude), and the "across" direction (azimuth). For ordinary small telescopes this manipulation is not so bad as it sounds, since the two little movements are made quickly and in a sort of stairway pattern. Many who have used both types of mountings defend the alt-azimuth with vigor against all who pick on it. They don't claim that it is better than the equatorial, or even quite so good, but they do assert that, in some ways, it is almost as good, and that in any case it is not to be looked at down the nose.

However, when the telescope is to be driven mechanically, and especially when it is to be used for photography, an equatorial mounting, having one axis parallel with the Earth's axis and the other at right angles to it, is a necessity; for here the alt-azimuth is, or thus far has been, out of the running, since it will not make the necessary double corrections automatically.

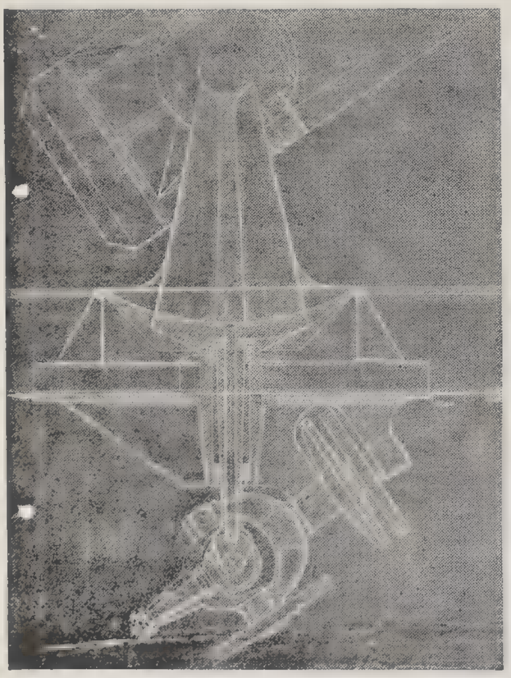


Figure 1: Original sketch, 1936

This is one reason why all our great telescopes are equatorially mounted.

This situation struck A. B. Hendricks, Jr., 115 Wendell Ave., Pittsfield, Mass., one of the earlier followers of the amateur telescope making hobby, as remediable. Why not use a mechanical linkage that would combine the altitude and azimuth motions automatically into a single, smooth equivalent of the equatorial motion?

After some study he drew up the simple sketch shown in Figure 1 (taken from an old notebook and therefore not in ideally reproducible form). In the upper part of this sketch is a telescope tube mounted on a vertical axis which rotates in azimuth. This vertical axis is driven through a linkage from another axis set diagonally (parallel with that of the Earth) and therefore an equatorial axis. Hendricks, when he sketched this proposal in 1936, called it a "transformer, equatorial to alt-azimuth." The diagonal element is driven at a uniform rate. The object sought is essentially to drive the altitude and azimuth at the desired *non-uniform* rates. In 1936 this sketch (Figure 1) was offered, through R. W. Porter, for the 200" mounting, but it proved that this type of mounting had already been considered by those who were designing the telescope, but not employed because of the difficulties involved in overcoming the rotation of the image on plate, inherent in it.

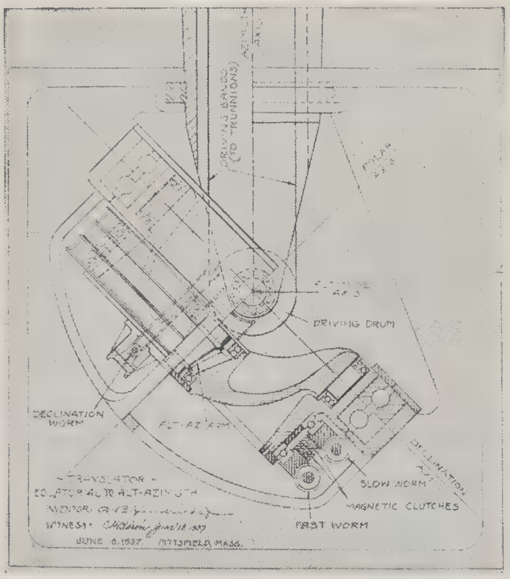


Figure 2: Subsequent version

Figure 4: Polar axis and bearing, setting and az circles, rear of tube

A year later Hendricks evolved the proposal shown in Figure 2 (another notebook sketch). This again shows a miniature equatorial placed below the alt-azimuth. In Hendricks' language, "the arched declination axis carries, pivoted within it, a spindle rigidly connected in a radial direction to the driving drum, which in turn is pivoted horizontally in the lower end of the azimuth axis on ball bearings. The horizontal component of the motion of the declination axis is transmitted directly to the driving drum, and through the axis of this drum (altitude axis) to the hollow vertical spindle (azimuth axis). The vertical component is also transmitted directly to the driving drum and thence through the steel driving bands to the telescope trunnions, through a cross-shaft within the pedestals, and two additional sets of drums and bands. Some parts are shown in half section."

In 1936, Hendricks had discussed the problem with H. F. Morse, Sasco Hill, Southport, Connecticut, and Morse set off

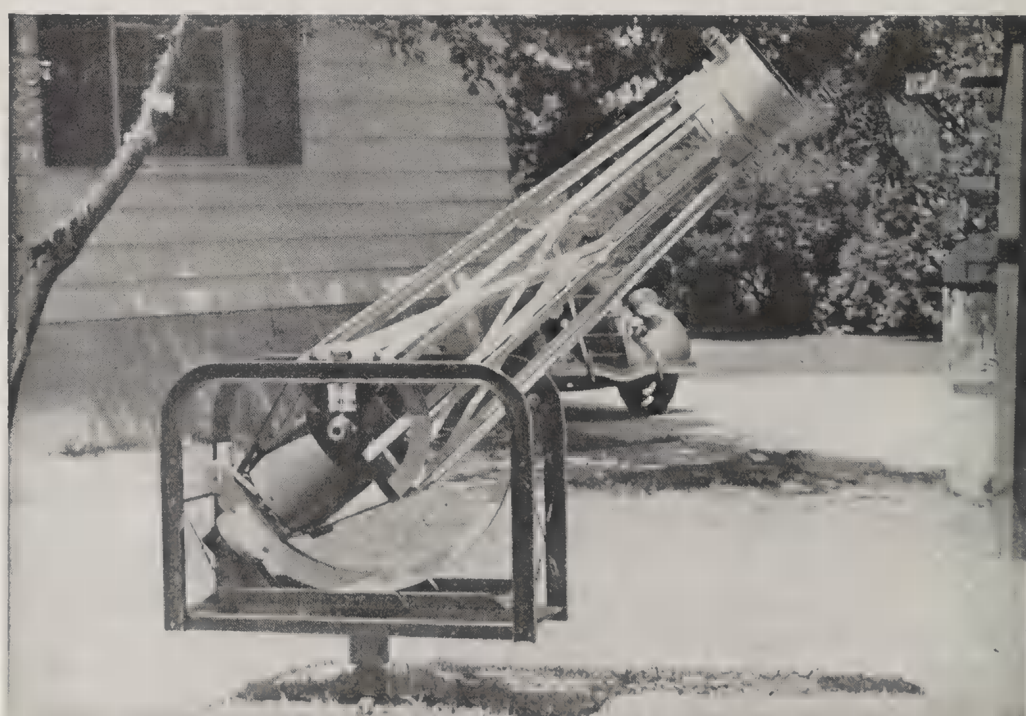


Figure 3: The altogether unique Morse alt-azimuth mounting

to accomplish the equatorial-to-alt-azimuth transformation in an entirely different manner (Figures 3, 4). He made the telescope mounting shown, and has exhibited this telescope several times at the conventions of amateurs held at Stellafane, near Springfield, Vermont, where it is always surrounded by a knot of by-standers.

To many, on first seeing it, the working principle is a puzzle. The principal unique feature of the Morse mounting is the curved, scimitar-like member seen in the photographs. This is the link, in the Morse

Figure 5: Close-up of carriage

version of the concept, which automatically brings about the desired transformation of uniform motion into non-uniform motion.

But let's begin at the beginning. The following is a composite of Morse's description and your scribe's efforts—errors, if any, being chargeable to the latter.

At the very bottom (Figure 3), almost hidden in the grass and the shadow, is a bird's-foot base, holding in its center a short, stubby, vertical shaft.

Supported on this shaft by Norma-Hoffman ball bearings is a large rectangular frame of fabricated metal, which can be rotated about this vertical axis.

Near its top part this frame supports the horizontal axis bearings. The hollow end of one of the horizontal axis trunnions shows clearly in the photograph.

Supported on the upper end of the stubby vertical shaft of the base mentioned above, in addition to the rectangular metal frame just described, is a trough-shaped platform (see also Figure 4) which is tightly clamped to the shaft. At one end of this platform rises a diagonal bracket. This bracket contains the bearing for another stubby shaft, the polar axis shaft.

On this stubby polar axis shaft is mounted the long, curved member—the alt-azimuth circle. This curved member, which is supported only at one end, can be rotated about the polar axis just described; that is, in Figure 3, swinging toward and away from the eye (like a sickle turning in the hand when the wrist is rotated but not otherwise moved). Its radius of curvature in any such rotational position remains in the common point through which the three axes—optical, horizontal, and polar—pass.

Slidably mounted on the curved inner surface of the alt-azimuth circle is a small carriage (Figure 5). Between the two sets of wheels of this carriage is a disk with a central hole (actually, this disk is a small ball-bearing). This disk is mounted in such a way that its bore always points toward the point through which the telescope's

axes pass. The telescope tube, mounted on the horizontal axis, carries, at a central point in its bottom, a short pin, and wherever the tube is pointed this pin remains inserted in the central hole of the bearing.

In Figure 3 the tube is so positioned that its optical axis coincides with the polar axis and *in this one special position alone* the curved member can be swung without moving the tube. However, when the carriage is moved along the curved member (Figure 4), and the curved member is then moved (by rotating the short polar axis at its end), the optical axis is caused to rotate around the fixed polar axis and the telescope is automatically constrained to follow the star toward which it is directed.

Another way to explain this unique drive would be the following: Follow a star for a time by means of an ordinary alt-azimuth mounted telescope. Then the trace of a given point at the rear of the mirror would take the form of a curve like the curved member of the Morse telescope.

When handling the tube of this telescope one has the feeling that an invisible spook also has hold of it, since it resists attempts to move it in any direction other than one which would follow a star. For example, if one tries to move it only in azimuth, it insists on moving at the same time in altitude. The "spook" is the curved guiding member.

What advantages does Morse claim for this mounting?

"The object," he states, "was to avoid certain inherent shortcomings in large equatorial mountings.

"Estimates indicate a much lower cost. Materials could be better used—with lessened total weight.

"Because there would be no transfer of weight from one bearing to another, there would be no distortion of parts.

"Because of ease and flexibility of the adjustments, less precision work would be required on various details.

"Astronomers would work in an always level position and in a constant temperature room at either end of the horizontal axis, where light could be directed with three reflections.

"Because the tube moves about the horizontal axis in one plane alone, the tube could be made very rigid and at the same time relatively light. The whole instrument could be floated in an annular tank of mercury, thus leaving only enough weight on the annular track (precision ground) to insure accurate rotation around the vertical axis."

Amateurs who aspire to build 200″ telescopes usually start more modestly, say with a 100″ telescope, and work up by 100″ stages. Erl A. Dart, 2466 S. Bannock Street, Denver, says he had never before built a complete telescope, so he simply started right out on the 200″ telescope shown in Figure 6. The job consumed 60 hours of time, $4 worth of brass and two watch crystals (for the mirrors): it's a model, 3/32″=1 foot.

If you don't want to buy, or in present times can't buy, a synchronous motor for a telescope drive, there is a way to make one yourself, and C. J. Myers, 417 N. Virgil Ave., Los Angeles, Calif., explains it thus:

"It may be that most amateurs are not aware that almost any AC motor can be converted into a synchronous one. A washing machine motor, fan motor or, for that matter, any squirrel cage motor will do.

"All that is necessary is to determine the number of poles and cut an equal number of flat spots on the rotor. For example: a 4-pole motor would have a rotor divided into 8 equal spaces. Cut every second or alternate area down about 3/16″. The easiest way to do this is to set the rotor off center in a 4-jaw chuck—although a milling machine will do a better job, as the rotor should be balanced afterward. The motor will now have about one-third its original H.P. at synchronous speed.

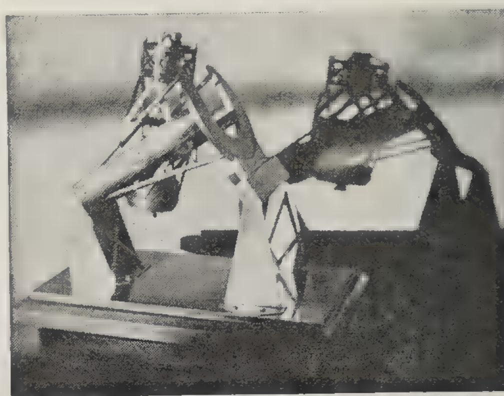


Figure 6: The 200" and its ghost

"The number of poles equals the frequency $\times$ 2 $\times$ 60 divided by the nearest synchronous speed up (based upon the number of cycles).

"Most small motors are 4-pole. If the rotating element is cut, it should be balanced. The usual method is to have two parallel knife-edges (any sharp straight metal) on which the motor is rested on its bearings. Small holes are drilled in the heavy side until it will come to rest in any position.

"The governor fly balls on all generators at Boulder Dam are driven with this type of motor. The speed drift is about the lowest in any power house built today."

Asked to supply a little background data on motors, Myers writes: "This motor speed business seems to confuse a lot of people. All motors having salient poles (with teeth) run synchronous. All motors with round rotors (without teeth—smooth) will have a definite slip below synchronism in proportion to load. This is where my formula comes in. Usually the name plate on this class of motor indicates the speed at full load. For example: the synchronous speed for a 4-pole motor, on 60 cycles, is 1800 rpm, but the average motor runs 1760 rpm. The same motor on 50 cycles synchronous is 1500 and the motor runs 1440. The formula for a synchronous motor is frequency $\times$ 2 $\times$ 60 divided by number of poles. In other words, any motor that is converted will speed up about 5 percent. Any good winding shop could change the number of poles within limits depending on the size of the motor."

No convention of amateur astronomers will be held at Stellafane, Springfield, Vermont, this summer. Reason: War. Few could attend because most amateurs are doing war work (also saving tires). Springfield itself is too busy (working seven-day weeks) and too overcrowded to entertain.

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